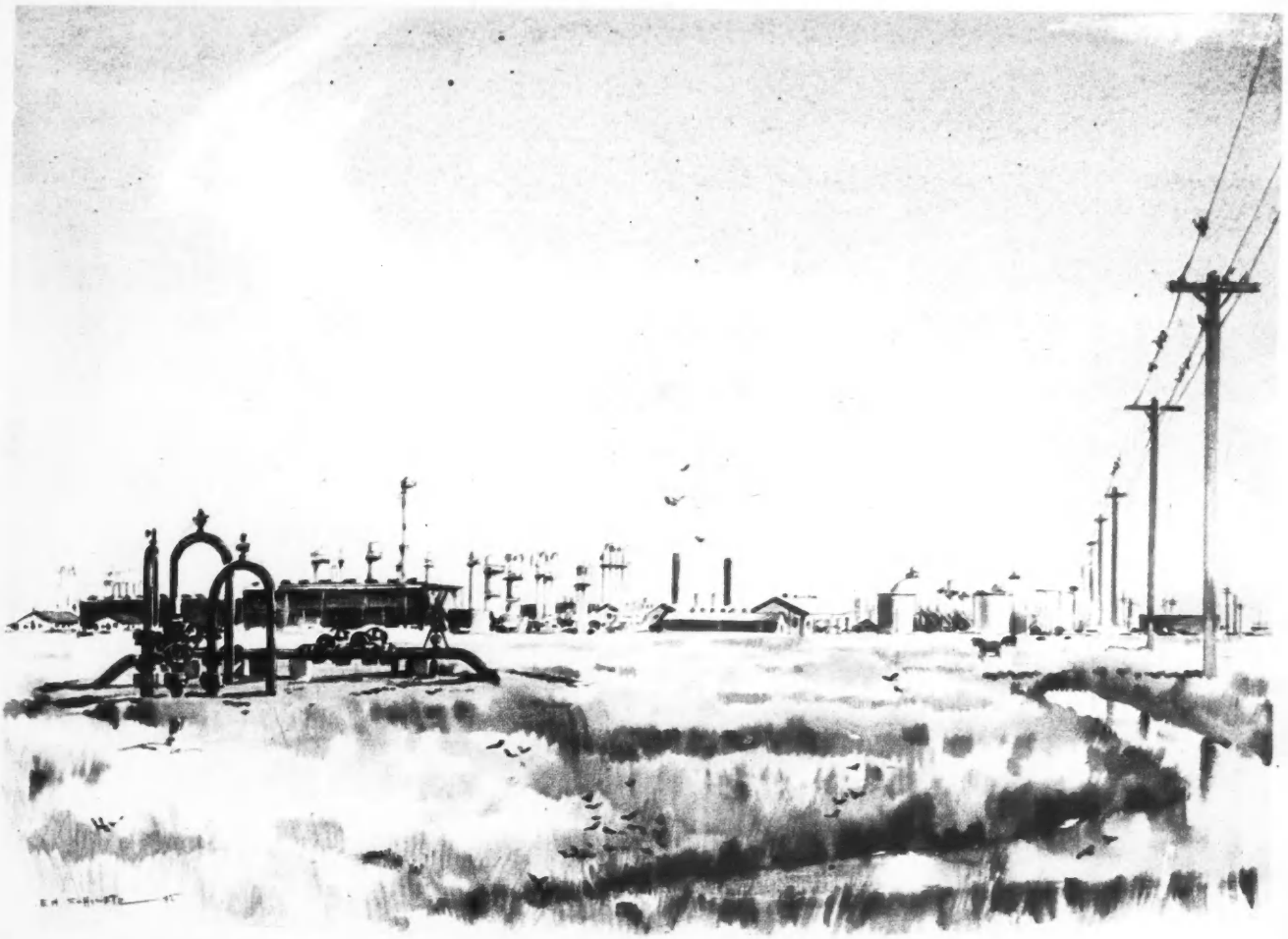


Katy Cycling Plant

The HUMBLE WAY

NOVEMBER-DECEMBER, 1945

The HUMBLE WAY

Vol. 1 NOVEMBER-DECEMBER, 1945 No. 4

MORE FOR LESS

Benefits of New A&T Plan

ONE of man's most deep-rooted desires is for security; security of earning power during his working years to insure the establishment and welfare of his home and family; security for himself and his loved ones in the evening of life.

Progressive American industrial organizations for many years have sought to fulfill this basic human desire, convinced that employees who enjoy real security are stable, devoted, loyal, and happy. Since shortly after the Humble Company's organization in 1917, it has been a leader in this field in the Southwest. Humble has attempted to provide the best possible employment insurance for its people by stable operations throughout its years of growth, and since 1920 has had some form of old-age annuity plan for them. To assist employees in providing for themselves the best possible retirement program, the Company has modified and changed its Plan from time to time to meet the demands of changing conditions.

Just such a change will become effective on January 1, 1946, when a new Annuity & Thrift plan replaces what is commonly referred to as the 1936 Plan. The new Plan embodies a number of changes and additions, every one of which benefits employees; it literally gives employees more for less. Primarily, it provides a greater career annuity for male and female employees alike at a lower cost to them; it provides for five-year certain payment of annuity benefits; it provides a temporary allowance for those choosing early retirement; and it continues to provide the same thrift features as in the past.

Let's begin by looking at the thrift feature. Under the '36 Plan an employee could contribute an amount varying from three to 13 per cent of his total pay. To this the Company added one dollar for every employee dollar up to the first three per cent, and 50 cents for each additional employee dollar. For example, an employee earning $300 a month, who participated at the rate of 13 per cent of his salary contributed $39 and the Company added $24. Of this total, an amount equal to the $24 Company contribution (made up of equal parts of employee and Company money) had to be allotted to the purchase of annuities. The balance remained in the Thrift Fund. Under the new Plan an employee may still decide what percentage of his total pay he wants to contribute to the Thrift Fund, but the schedule is different. It must be in even percentage figures, ranging from a low of two percent to a high of 10 per cent. But just because the maximum has been set at 10 per cent does not mean that employees cannot save as much as before; the Company adds to employee money 50 cents for each dollar on the first two per cent and 25 cents for each additional dollar. Thus, the employee who contributes the maximum 10 per cent finds that the Company adds three per cent to that, making it 13 per cent of his salary going into Thrift just as in the '36 Plan.

Thrift Contributions
Based on Total Earnings for Each Pay Period

Employee	Company	Total
2%	1%	3%
4%	1½%	5½%
6%	2%	8%
8%	2½%	10½%
10%	3%	13%

All other phases of the Thrift end of the Plan remain about the same, with one exception, withdrawal privileges. Under the '36 Plan each participating employee could withdraw once a year a sum not more than one-third of his and Company regular contributions plus one-half of fund earn-

SPHERICAL STORAGE TANKS for products made from natural gas at Katy Gas Plant, near Houston.

ings and Company additional contributions. Under the new Plan employees are permitted to withdraw once a year a sum not more than two-thirds of their own contributions plus two-thirds of fund earnings and Company additional contributions. Although the new formula is appreciably different from the old, in actual practice the amount withdrawable is about the same.

So much for the Thrift feature of the Plan; now let's look at the Annuity provisions. Money to buy annuities will come from two sources, as in the old Plan: from Company contributions and from deductions from the employee's pay check, made once a month on the basis of a salary schedule very much like the schedule used in determining group insurance. (See chart.) Each employee's rate of payment is fixed for the whole calendar year and is based on his rate of pay as of the previous October 1. Let's take for example our $300-a-month employee who has signed up for the new Plan. He will find that according to the schedule, $6 will be deducted from his pay for the period between January 15 and February 1, 1946. This deduction is independent of his Thrift deduction, which is made from every pay check, and will remain the same every month during 1946 even though his salary may change in the course of the year to place him in another bracket. The change in the amount of deduction will not come until January, 1947, based on his salary schedule as of October 1, 1946.

Employee Monthly Income and Annuity Contribution

Straight Time Earnings Oct. 1	Contribution For Annuities	Straight Time Earnings Oct. 1	Contribution For Annuities
Under $100	$ 1.32	265 to 315	$ 6.00
$100 to 116	1.68	315 to 375	7.80
116 to 132	2.04	375 to 435	9.60
132 to 148	2.40	435 to 495	11.40
148 to 164	2.76	495 to 555	13.20
164 to 180	3.12	555 to 615	15.00
180 to 196	3.48	615 to 700	17.04
196 to 212	3.84	700 to 800	19.80
212 to 228	4.20	800 to 900	22.80
228 to 244	4.56	Increases by	Increases by
244 to 265	5.04	$100 per Month	$3.00 per Month

Another new feature of the overall Plan is that an employee may take part in the Annuity program without participating in the Thrift feature, but he cannot be in the Thrift Plan without also being in the Annuity provision.

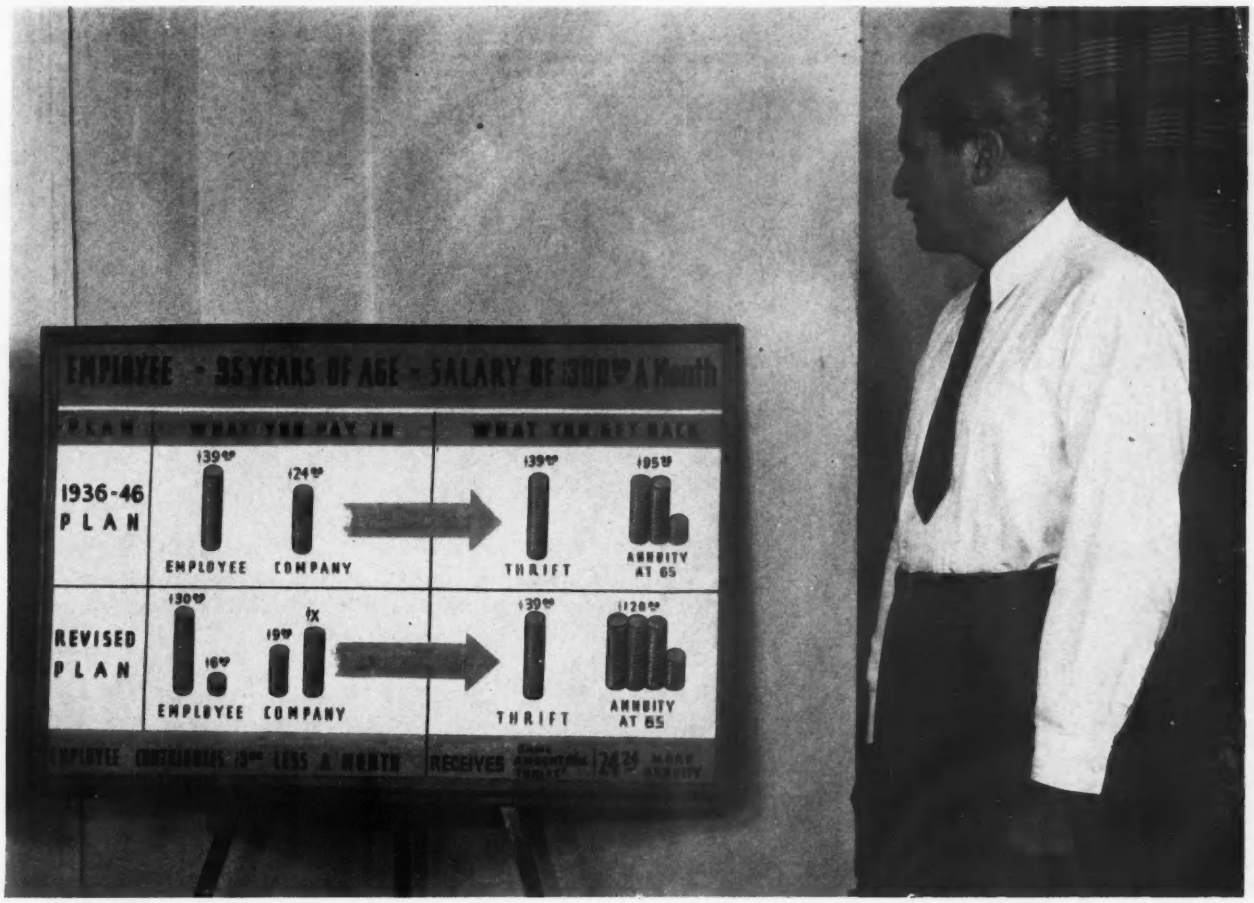
All Annuity contributions will continue to be used only for the purchase of group annuities; the main purpose of the new Plan is to provide a greater career annuity than has been bought under the '36 Plan at no increased cost, and in most cases at a smaller cost, to employees. That obviously means a greater cost to the Company, and it is estimated that it will amount to about two per cent of the total payroll. The amount of annuity provided under the new Plan is tied in with the Social Security Act in such a way that between the two the employee will receive at normal retirement age an annual annuity equal to about two per cent, or slightly more, of his normal earnings for each year he has been in the Plan.

The table on page 3 shows the annuity payable to employees every year for the rest of their lives beginning at age 65 (women 55). It covers only the amount derived from the Annuity Plan and does not include Social Security benefits.

The table points out one of the better features of the new Plan. From it the employee can always figure exactly what he has built up in the form of annuity benefits. While no employee can know which earning class he may be in in future years, he will always know currently what his annuity accumulation is.

Naturally, the insurance companies still charge more for an annuity for a man age 60 than for a man age 25 and more for an annuity for a woman age 45 than for a man

REGARDLESS OF AGE, ANNUITY DOLLARS INVESTED BY EMPLOYEES BUY THE SAME AMOUNT OF RETIREMENT INCOME.



COMPARATIVE CHART SHOWS CHIEF ADVANTAGE OF NEW PLAN IS IN GREATER ANNUITY BENEFITS FOR EMPLOYEES.

age 45, but it is here that the new Plan becomes of special interest to every participant. Regardless of age or sex, every employee's dollar contribution buys the same amount of annuity because the Company provides the additional money necessary to make this possible.

So that employees may readily see how much they benefit from the new Annuity Plan, here is a simple fact: For every three dollars contributed to annuities under the new Plan, the employee receives a two-dollar annual annuity for the rest of his life, beginning at age 65 (women 55). Our $300-a-month example employee, for instance, will pay into the Plan in the course of his 30 years a total of $2,160. At age 65 he will begin receiving a monthly annuity of $120. By the end of 18 months after retirement, then, he will have received $2,160, or every cent he invested. But his payments do not stop then. He has, under the new Plan, a guaranteed five-year certain annuity, which means that he, if he lives, or his designated beneficiary if he dies, will collect at least $7,200 in annuity benefits. Thus, after normal retirement, every participating employee or his beneficiary will receive at least $10 for every $3 invested.

Straight Time Earnings Oct. 1	1 Year	10 Years	20 Years	30 Years
Under $100	$ 10.56	$ 105.60	$ 211.20	$ 316.80
$100 to 116	13.44	134.40	268.80	403.20
116 to 132	16.32	163.20	326.40	489.60
132 to 148	19.20	192.00	384.00	576.00
148 to 164	22.08	220.80	441.60	662.40
164 to 180	24.96	249.60	499.20	748.80
180 to 196	27.84	278.40	556.80	835.20
196 to 212	30.72	307.20	614.40	921.60
212 to 228	33.60	336.00	672.00	1008.00
228 to 244	36.48	364.80	729.60	1094.40
244 to 265	40.32	403.20	806.40	1209.60
265 to 315	48.00	480.00	960.00	1440.00
315 to 375	62.40	624.00	1248.00	1872.00
375 to 435	76.80	768.00	1536.00	2304.00
435 to 495	91.20	912.00	1824.00	2736.00
495 to 555	105.60	1056.00	2112.00	3168.00
555 to 615	120.00	1200.00	2400.00	3600.00
615 to 700	136.32	1363.20	2726.40	4089.60
700 to 800	158.40	1584.00	3168.00	4752.00
800 to 900	182.40	1824.00	3648.00	5472.00
Increases by $100 per Month	24.00	240.00	480.00	720.00

Of course, if the retired employee lives on for a number of years after that five-year certain period, he continues receiving his regular annuity check for his entire life after 65.

But many an employee is interested in some form of arrangement which would permit him to retire before 65 (women 55). That, too, has been provided under the new Plan. With the approval of the Company and subject to qualifying under the 1932 Annuity Plan, if it applies, women may retire as early as age 50, men as early as age 55. Naturally, the amount of the annuity will be appreciably smaller if an employee elects to retire prematurely, since the employee begins to collect earlier and pays in fewer years. The schedule, top of page 4, shows the reduced rate of annuity payments made to employees retiring early.

GUARANTEED FIVE year certain annuity payments insure each participant's receiving at least ten dollars for every three dollars invested. Men and women alike may choose early retirement and take advantage of the temporary allowance feature of the new plan.

Early Retirement Annuity Reductions

Years Before Normal Retirement	Approximate Percentage Reduction	
	Women	Men
1	6	9
2	12	17
3	17	24
4	21	30
5	25	36
6	..	41
7	..	45
8	..	49
9	..	53
10	..	56

However, another special provision has been added to the new Plan to compensate for the reduced annuity payments —a *temporary allowance* feature. This is actually a fill-in allowance provided by the Company until Social Security payments commence at age 65, and when added to reduced annuity payments received by the employee retiring early it helps to build a fairly substantial income. The annual amount of such an allowance will be ¾ of one per cent of the employees total earnings (up to $3,000 a year) received during membership in the Annuity & Thrift Plan since January 1, 1936.

The following table gives an approximate idea of what these allowances would be:

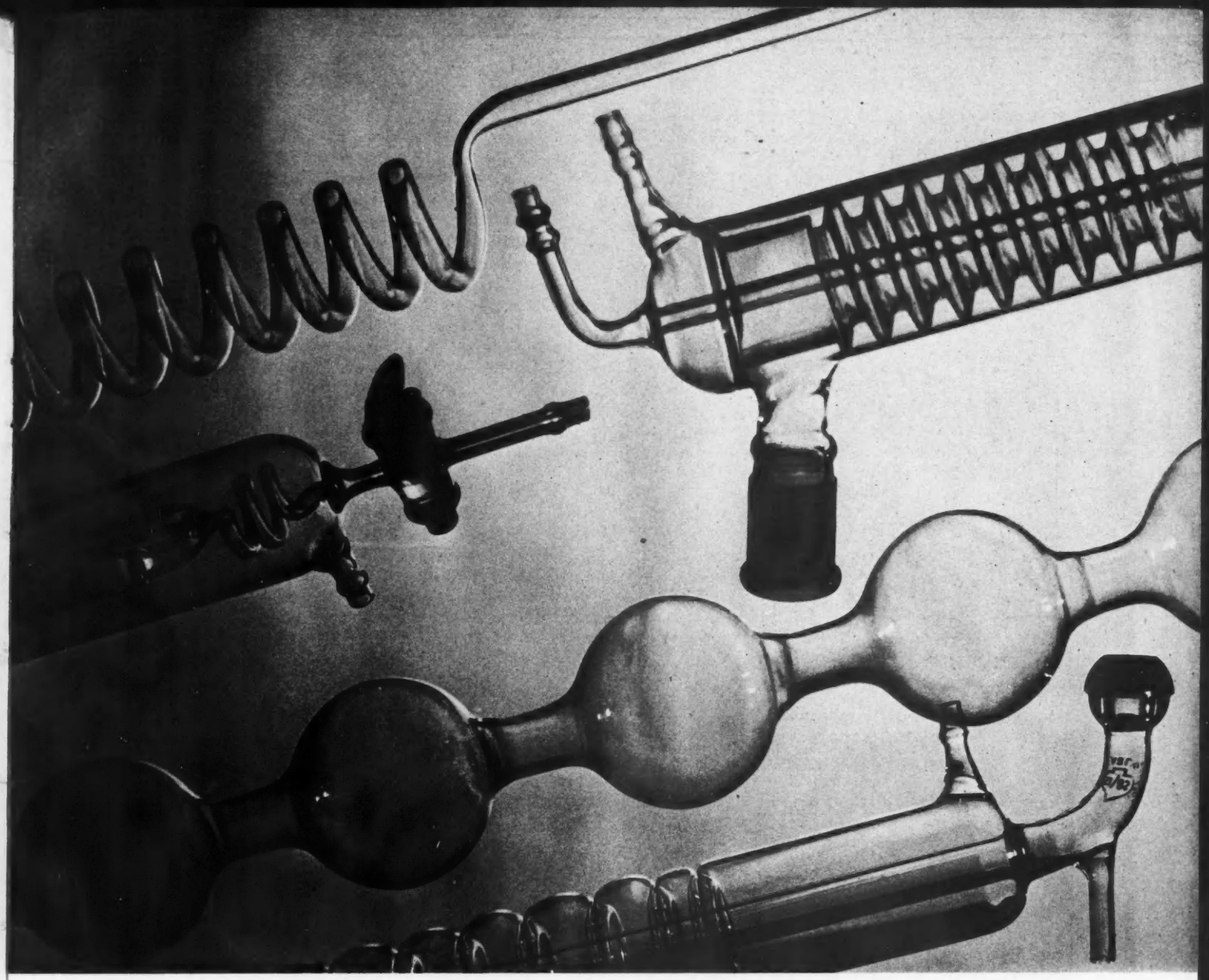
Yearly Earnings Averaged At Retirement*	Temporary Yearly Allowance Assuming that at Retirement You Had Participated in the Annuity and Thrift Plan						
	5 Years	10 Years	15 Years	20 Years	25 Years	30 Years	35 Years
$1,000	$ 37.50	$ 75.00	$ 112.50	$ 150.00	$ 187.50	$ 225.00	$ 262.50
1,200	45.00	90.00	135.00	180.00	225.00	270.00	315.00
1,400	52.50	105.00	157.50	210.00	262.50	315.00	367.50
1,600	60.00	120.00	180.00	240.00	300.00	360.00	420.00
1,800	67.50	135.00	202.50	270.00	337.50	405.00	472.50
2,000	75.00	150.00	225.00	300.00	375.00	450.00	525.00
2,200	82.50	165.00	247.50	330.00	412.50	495.00	577.50
2,400	90.00	180.00	270.00	360.00	450.00	540.00	630.00
2,600	97.50	195.00	292.50	390.00	487.50	585.00	682.50
2,800	105.00	210.00	315.00	420.00	525.00	630.00	735.00
3,000 & Over	112.50	225.00	337.50	450.00	562.50	675.00	787.50

* (Based on period you participate in Annuity and Thrift Plan since 1-1-36.)

Still another feature of the new Plan of interest to a great many employees is the special consideration given men and women employees returning from service with the armed forces or with government agencies. If such employees were participants in the Plan when they left, and after they participate in the new Plan for one year, the Company at its expense will buy for them as much annuity as they would have secured during the entire period of their war service. This annuity purchase will be based on the regular earnings of these employees when they left for war service.

Other features of the new Plan, of less general interest, are explained in the official booklet and the "High Spots" booklet given to all employees, as well as in a motion picture entitled "When That Time Comes," prepared by the Visual Education section of the Safety & Training Division for showing to employees everywhere in the Company.

From these several sources employees will have an opportunity to gain a complete understanding of all phases of the new Plan and an appreciation of the fact that the Plan truly brings them *more for less*.



INTRICATE PATTERNS OF GLASS LABORATORY EQUIPMENT TESTIFY TO SKILLFUL ARTISTRY OF MASTER GLASS BLOWERS.

BLOWN TO SPECIFICATIONS

Glass blowers who fashion intricate laboratory equipment play vital role in petroleum research

Constantine the Great, from his emperor's throne in dazzling Byzantium, ordered that all glass blowers be exempt from taxes, so indispensable had they become to the empire's economy, and Caesar Augustus once demanded that his conqueror's spoils be paid in glass. The cunning merchants of Venice attempted to corner the world's greatest glass craftsmen and meted out hideous punishment to anyone who divulged to any other city-state the secret of glass blowing, for glass to the ancients was as valuable as priceless gems. Yet, the discovery of glass and the first evidence of its production are cloaked in the dim beginning of unrecorded Time.

We do know that it was discovered and that somewhere along the way man learned to use a blowpipe, which revolutionized glass history. Down through the centuries to our time there has always been an important place for glass blowers, and the craft is as skillful and as painstaking and as artistic as it was in ancient times.

Today the glass blowers' fraternity is a small, compact one with only about 4000-5000 recognized members in the

DELICATE FIGURES of birds and animals are created during lunch hour to please the fancy of fellow employees. On a motor-driven lathe, operator below fuses a 12-liter distillation flask on to a six-foot distillation column. By means of this lathe, metal can be fused to glass and glass to glass; it allows the craftsman to manipulate large columns easily and smoothly.

United States, and there is not much prospect of its becoming larger, for although certain vocational schools can give basic instruction in the intricate art, experience is the chief teacher. Experience in glass blowing not only spans the art of molding glass to suit a sketch or blueprint, but it requires a thorough knowledge of glass itself and the needs of the research scientist.

Physically, glass is a collection and commingling of constituents such as silicon dioxide, sodium oxide, aluminum oxide, and boric oxide. It can be as fragile as the gossamer web of a small spider, or as tough as sinewy steel. In fact, incredible as it may seem, glass has a greater tensile strength than steel.

To master the complex craft of glass blowing and to become conversant with laboratory needs takes time; four to ten years is the usual period required for a glass blower to become adept at his profession, adequately acquainted with the problems of the research and the routine chemist, and qualified to create for them their needs in glass.

In an organization as diversified and as progressive as Humble one would expect to find artisans of most every kind, and sure enough, tucked away in one of the laboratory buildings at big Baytown refinery is a glass blowers' shop where three employees practice this age-old art. In a setting of countless tubes, burners, and large and small finished glass products, these men fashion with what seems an almost effortless skill the myriad of glass apparatus that are used in the laboratories.

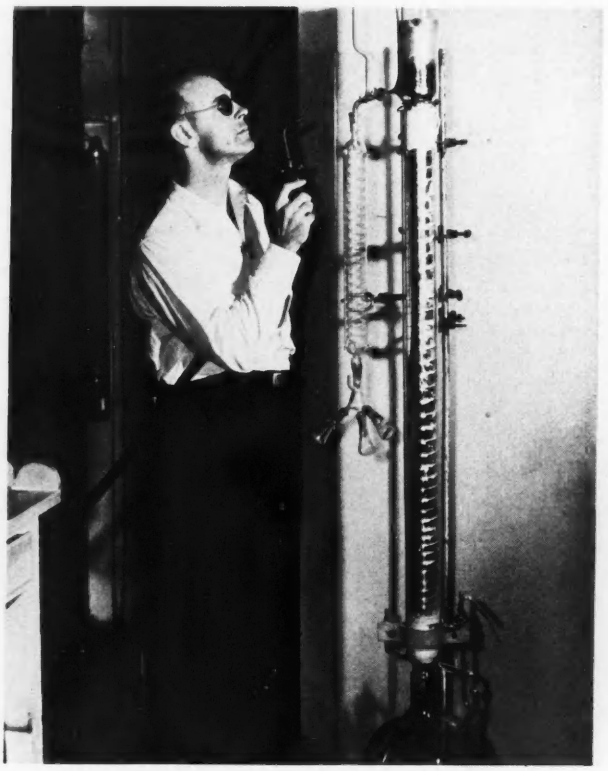
The tools of the glass blower are few. A burner, a carbon reaming tool and a metal reaming tool, a blowpipe, and an elongated pair of tweezers—these and years of experience enable him to create practically any pattern imaginable. Blueprints or sketches of what the laboratory researcher needs are sent to the glass blower. He studies them carefully to determine the size, shape, and thickness of the glass and the best method of construction. Then he is ready.

A flick of a spark, and the burner comes on with its hot, darting flame. adjustable to a fine pin-point or to a thick, brushy heat. In the hands of the blower the glass spins over the flame. becoming hotter and hotter until it reaches a slightly viscous, semi-liquid state. Then by blowing through the hollow of the glass tubing, and rotating as he blows, the glass craftsman can shape the tube any way he desires. for the

glass is pliable and responsive to blowing and twirling. With his reaming tools he can flatten or curl the surfaces; with his tweezers he can snip off unwanted portions.

When the glass has assumed the shape he wants and his job is completed, the finished product is allowed to cool evenly. It is then reheated, or annealed, to allow the molecules to stress-relieve themselves and make the glass less brittle. Result: a durable, practical piece of laboratory equipment.

In the boundless routine and exploratory activity conducted in the laboratories at Baytown refinery lie the past, the present, and future of superior petroleum products. Many tools of the researchers are made of glass—glass tubes, flasks, columns, even miniature glass refining units. All of these are fashioned in the glass blowers' shop, and that is why three employees at Baytown, craftsmen in an art practiced before the time of written records, are important in that unending search for more of the secrets locked in every drop of crude petroleum.



TESTING FOR leaks with a 66,000-volt electric detector. Sparks converge at the point of any porous opening or crack. Below, a portable burner is used to put finishing touches on an analytical distillation column. Lower right, blowing the numerous tiny acid titration bulbs used extensively in all laboratory work.

POZIT
the
PEACEMAKER

Twelve Humble employees share in perfection, test, and production of revolutionary VT or Proximity fuse for shells and bombs

COMPARATIVELY SMALL and unimpressive in appearance, the Proximity Fuse proved to be one of America's most potent secret weapons.

AFTER von Rundstedt tried and failed at the Battle of the Bulge, U. S. doughboys were enthusiastic about the enormously successful artillery concentrations which supported them. Antiaircraft gunners pointed with glee and pride to the gleaming new swastikas painted on their guns. And German prisoners of war spoke with respect and even awe of a new, "inhuman" secret weapon used by the Allies; an electro shell they called it, or a device activated by the magnetic pull of the earth—in any case, they couldn't take cover from it in foxholes or trenches and it killed their comrades by the hundreds.

Thus—and it was dramatic—the "Pozit," Proximity, or VT fuse for artillery shells was first committed on any considerable scale to battle in Europe. Its use there followed its brilliantly successful use by the Navy against Japanese airplanes in the Pacific, successes in which the kill scores of Navy gunners had roused envy and admiration in the hearts of Army antiaircraft artillerymen deployed throughout the European Theater of Operations.

Until recently, the fuse itself, and all references to it, were labeled *secret*. But in September of this year, it was included among the now-it-can-be-told secrets of the war.

The story begins in 1940, well before Pearl Harbor. The country was conscious of its peril, and Army and Navy began an inventory of their weapons. Some were obsolete, many could be improved, all were surveyed with a coldly critical eye. Antiaircraft weapons, in particular, were carefully scrutinized. Our guns the experts conceded to be good; our fire control equipment, though far from perfect, was as good as any, and with experiments beginning in radar, could be ahead of most. But our ammunition was—well, suffice it to say that the "hit expectancy" was a very small percentage of the total number of rounds to be fired.

Fuses were the chief difficulty. By late 1940, the Army had a good mechanical time fuse but even this fuse left much to be desired. The reason was that the mechanical fuse must be cut, or set, before the round is fired. This required calculation of the setting (which was done mechanically in 1940, electrically today) transmission of the setting to a fuse cutter, manual setting of the cutter to match the transmitted data, insertion of a round in the fuse cutter, cutting the fuse, withdrawal of the round, passing the round to a loader, loading the round, and then firing the piece. By the time the last action in the series took place, the fuse setting for the specific angle of elevation and azimuth of the gun at the time of firing might be off by as much as one second: and in this day of high speed airplanes, a one-second mistake is a flat-out miss. According to the artilleryman's rule of thumb, your 350 miles per hour airplane travels 175 yards (525 feet) in a second!

If only a fuse could be devised which would detonate the shell at the precise instant its trajectory passed within killing distance of the airplane!

The National Defense Research Committee was established in late June of 1940. Led by Dr. James B. Conant, representatives of the Committee began conferences with the Navy Department Council for Research headed by Rear Admiral H. G. Bowen. These talks included the possibility of perfecting a proximity of influence fuse for bombs, rockets and artillery shells. The last was most important and the specification which must be met to convert possibility into fact was threefold: the fuse must be rugged enough to stand the shock of firing from a cannon; it must be triggered by proximity to the target; and its action must be correlated with fragmentation pattern of the projectile, for otherwise, as Captain G. T. Schuyler of the Navy's Bureau of Ordnance pointed out, the projectile would be nothing more than "the world's most complicated form of self-destroying ammunition." It would be a hard job to perfect such a fuse, perhaps an impossible job, but the rewards would be correspondingly great if the effort succeeded. NDRC, with the encouragement of the U. S. Navy, decided to try.

A Section T of Division A, NDRC, joined the other Washington alphabets, with Dr. M. A. Tuve of Chevy Chase, Maryland, as chairman. One of the two tasks assigned to Section T was "the development of 'influence' fuses of any type."

The NDRC contracted with the Carnegie Institute of Washington to do the work of development in its Department of Terrestrial Magnetism.

Considerable progress was made. The scientists went to industry for assistance, and the manufacturers of radio tubes and other parts, of batteries and electrical devices, put all their scientific and manufacturing resources at the disposal of Section T. The upshot was a decision that sufficiently rugged devices could be manufactured.

By that time it had been decided to make VT fuses for the field artillery as well as for antiaircraft guns. Field artillerymen had watched the development of the fuse from the beginning; they called it the answer to an artilleryman's prayer. For the effect of point detonating field artillery fuses is comparatively restricted, and ammunition with mechanical time-fuses has the same disadvantage as that used by the antiaircraft artillery—frequently it detonates too early or too late. Time-fuse burst must be observed and adjusted, and for that reason are not very effective at night.

By the fall of 1941, the work had progressed to a point where a development contract could be awarded, and the fuses manufactured on a commercial scale. Firing tests by the Navy indicated that 52 per cent of the fuses manufactured under this contract were operative; this score was the Navy green light for full production.

Inasmuch as the fuse was still under development (and it remained so until the end), and the work of supervision and control of manufacture called for expanded facilities and manpower not available at the Carnegie Institute, that fundation suggested the transfer of Section T to the Office of Scientific Research and Development (OSRD); in March, 1942, OSRD contracted with the Applied Physics Laboratory of Johns Hopkins University to take up where NDRC left off. It was a logical transfer: to make a rough generalization, the first work had been in the realm of pure science, and now it was necessary to enter that of science as applied to the needs of industry.

By that time, the basic design of the fuse was set. It was, in effect, a radio transmitter and receiver so small that it could be fitted into the restricted space occupied by the fuse in the nose of a projectile. It works like this:

At the instant of firing, a small glass vial of liquid electrolyte is broken and centrifugal action forces the electrolyte between the plates of a miniature battery. The battery becomes electrically active and within $\frac{1}{4}$ to $\frac{1}{2}$ second later a firing condenser has been charged with electricity. When the condenser is charged and a mercury safety switch has been opened, the fuse is "armed"; that is, it is set to detonate the projectile when it is influenced to do so by the proximity of a target. All this takes place by the time the projectile is four or five hundred yards from the gun muzzle.

As the projectile moves through the air at 2600-2800 feet per second, a rugged radio vacuum tube sends out electromagnetic waves at the speed of light—186,000 miles per second. These impulses are reflected back to the oscillator by the target—usually an airplane or the earth. As the projectile nears its target, reflected impulses become stronger. These interact with the transmitted pulses to create a *ripple* pulse which is amplified by rugged vacuum tubes. If the projectile comes within 70 feet of its target, the *ripple* pulse is strong enough to trigger a thyratron tube which acts as an electronic switch. This releases the electrical energy stored in the condenser which, in turn, operates an electric detonator. The latter sets off a booster charge, which sets off the explosive in the projectile.

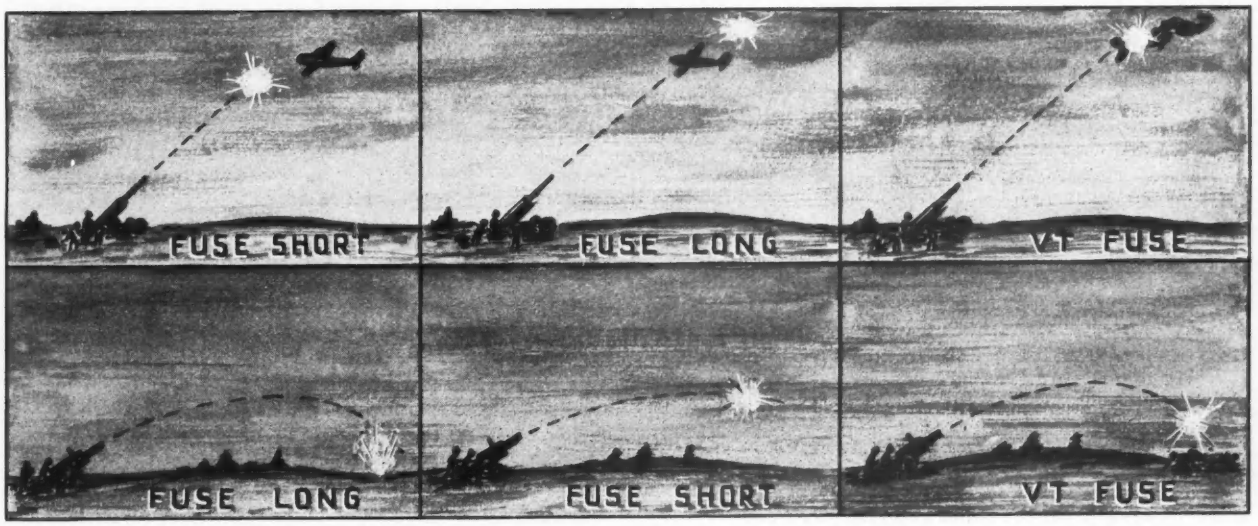
The fuse is so carefully devised that the *ripple* pulse will not set off the final series of actions until the projectile reaches a point on its trajectory where its area of fragmentation will include the target. The whole process of detonation requires only the fraction of a second.

Various safety devices are incorporated in the fuse. These make it "bore safe," that is, the chain of reactions cannot be completed while the projectile is still in the bore of the gun; and they prevent premature bursts just beyond the gun muzzle. The perfection of these devices is attested by the startling statistics that out of millions of rounds fired, the U. S. Navy and Army each reported only one premature burst, and neither of these could be unequivocally attributed to the fuse!

Antiaircraft fuses for use over land were further fitted with a self-destroying device to prevent duds from falling into the hands of the enemy.

VT fuses for field artillery were developed concurrently with the antiaircraft fuse and operate on the same principle, except that the radio wave is reflected from the earth instead

SKETCHES ILLUSTRATE EFFECTIVENESS OF VT FUSE OVER NORMAL FUSES IN ARTILLERY AND ANTI-AIRCRAFT GUNS.



SIX OF 12 HUMBLE EMPLOYEES WHO WORKED ON FUSE, L TO R: TULLOS, NEWSOME, ARTHUR, MANEVAL, BIES, AND LYTLE.

of an airplane. In use, bursts are at a uniform height above the ground, no observation is necessary except for range and azimuth, the ammunition is as effective at night as in the day, and a faster rate of fire can be secured.

The rush into production, the training of manufacturers and their employees, the testing and control of production, and a continuous improvement program taxed the ingenuity, the energy and the capacity of all connected with production of the fuse. It will be an everlasting tribute to the men of Section T, to the industries concerned, and to both the using services that they were able to cooperate with so little lost motion and with such wholehearted singleness of purpose to produce more and better VT fuses.

All this was complicated by the great need of secrecy. An official of the Navy Department stated that development of the VT fuse was secondary in importance only to the atomic bomb. It was *the* secret weapon for general use against the enemy. And from the time it was first mentioned until VJ day, it remained secret.

It seems almost impossible that the development work could have been carried on and many millions of fuses manufactured, without some hint of the activity reaching the enemy or the general public. Fuse parts passed through thousands of hands, hundreds knew a little about it, sailors and soldiers of the services had to be taught its use; but the Japanese and the Germans remained ignorant of all but its terrible effectiveness. And that master race, the Germans, had been puttering with the idea of such a device since the early 1930s!

A few top production men knew the whole story of the fuse, because they had to know it; others were familiar only with details of a *secret gadget*, which might be anything, but surely couldn't be a fuse for artillery shells—it was an electronic device and who ever heard of an electronic fuse! The plants in which the fuses and component parts were made achieved production records the equal of any in the country, but not one of them ever was awarded an Army-Navy "E"; award of the "E" might have started an Axis agent on a warm trail.

Many of the scientists who worked on the fuse were young men of draft age. They were engaged in work essential to the war effort—none more so! But they couldn't tell their draft boards what it was, and some of these were so insistent that excusing the young men from military service had to be arranged by their superiors with General Hershey himself.

The first hostile aircraft fell a victim to the accuracy of the fuse on January 5, 1943, when a projectile from the USS *Helena* brought down a Japanese plane in the Pacific. From that time until the end of the Pacific war, the Navy used the fuses with deadly effect. During 1943, projectiles from naval 5-inch antiaircraft guns were 75 per cent time fused, 25 per cent VT fused. Of the airplanes shot down by the Navy in 1943, 49 per cent were credited to time fuses, 51 per cent to VT fuses; the VT fuse proved 3.1 times more effective than conventional fuses.

In May, 1943, the radars of one of our task forces operating in the Coral Sea detected a flight of 10 Japanese bombers when they were 35 miles away. When the formation flew within range, guns were trained on them; the first plane was shot down at a distance of eight miles, and others dropped as they pressed their attack. Only two reached striking distance and launched torpedoes, and they were destroyed as they

tried to leave. The score was 10 out of 10—100 per cent—and the ammunition was VT fused.

The security reasons already explained prevented the employment of VT fused ammunition in the European Theater until the summer of 1944. Intelligence reports had forecast flying bomb (V-I) attacks on London, however, and the Joint Chiefs of Staff had agreed to use the fuses in defense against them, provided the guns were fired over water as in the Pacific. At the outset, however, the guns were located close to London, and a combined aircraft-antiaircraft artillery defense was attempted. This precluded use of the fuse. Artillery misses, exploding as they neared the ground, might conceivably cause as much damage to civilians as the bombs, and a friendly Spitfire might fly within the 70-foot radius of the fuse's radio signal. The combined defense was only fairly successful. It was decided to change the defense plan, move all guns to the coast, restrict the area of the gun defense against flight by friendly aircraft, and place heaviest reliance on the VT fuse. In the final week of the V-I attacks, antiaircraft proved claims of 75 per cent of bombs destroyed.

The Army was sold on the VT fuse!

But it was still not released for general use over land. It was decided, however, to indoctrinate using personnel. This was begun in September, 1944, and finally the Joint Chiefs of Staff gave permission to use the fuses against the Wehrmacht; General Eisenhower set the date—Christmas Day, 1944—when what was hoped would be the last great offensive was scheduled to start.

The German Ardennes offensive upset all plans. On December 16, Supreme Headquarters, Allied Expeditionary Force, released the fuses for antiaircraft use, and two days later, they were released for use by field artillery.

The official report states, "In both the A.A. and ground role, VT fuses have constituted a factor not foreseen in Von Rundstedt's calculations . . . the terrific execution inflicted and the consternation resulting from night and day bombardment has contributed materially to halting the advance and hastening the reduction of the salient . . . the effectiveness of VT fuses exceeds our expectations."

For the first time in the history of warfare, devastating air bursts were obtained over targets, night and day, as far distant as 15 miles.

From that time on, the Wehrmacht suffered heavily from the deadly ammunition which, according to a typical PW report, burst "several meters above the ground." He went on to say, "The fragments . . . penetrate a layer of earth one meter in thickness. The fragmentation effect is tremendously great within an area of 60 meters. At Linnich, one battalion after 30-40 shots lost 315 men killed and wounded."

The antiaircraft artillery matched the enthusiastic reports of the field artillerymen with their own. A 90-millimeter battalion shot down 39 Luftwaffe bombers within three days after it began to use VT fused ammunition.

When VT fuses were released for use against Von Rundstedt they were also released to the antiaircraft battalions defending Antwerp, chief U. S. supply port, against V-I attack, which was as serious from a military viewpoint as the attack on London. Prior to release of the VT fuse, U. S. artillerymen had achieved an accuracy of antiaircraft fire with time-fused projectiles which had won the admiration of the gunnery experts of the European Theater. With VT fused ammunition, their scores began immediately to climb: up to 80 per cent of the V-I bombs launched against Antwerp were destroyed.

VT fuses for bombs and rockets have only been mentioned, yet VT fuses were used in many of the gel-gas bombs dropped on Japan.

Success of the VT fuse is a tribute not only to the 195 civilian scientists, including 12 Humble employees, listed by John Hopkins University as having participated in its development; 19 Naval officers, a number of Army officers, 26 industrial organizations, and 110 plants contributing to its production; but it is also a tribute to thousands of American men and women who worked on the production lines from which they flowed and to other thousands of young Americans who employed this deadly weapon so effectively to hurry the day of peace.

HUMBLE EMPLOYEES SHARING IN VT SUCCESS

M. A. ARTHUR—geophysicist in Geophysics Research went to Carnegie Institute on special leave in June, 1942. Was in safety device section at Johns Hopkins University from July, 1943, until Bureau of Ordnance of Navy took over in November, 1944. Worked on safety device—in research, production and supervision of manufacture. Returned to same post with Company November 1, 1945.

J. C. JACOBS—junior engineer in Geophysics Research went to Department of Terrestrial Magnetism, Carnegie Institute, on July 7, 1942. Was liaison man between DTM and Johns Hopkins and manufacturers. Has resigned from Company.

J. A. NEWSOME, JR.—junior research engineer in Production Research went to Applied Physics Lab at Johns Hopkins in April, 1942. Worked in production, quality control in mass production of fuse, and as liaison between laboratory and producers. After fuse program settled down, began work on new gun director development program. Returned to same post at Humble in March, 1945.

T. W. LYTLE—seismograph operator in Geophysics exploration went to Applied Physics Lab, Johns Hopkins, on November 23, 1942. Was in testing end of work, devising various tests for fuses and auxiliary equipment. Returned to same post with Humble on October 11, this year.

J. N. TULLOS—assistant geophysicist went to Maryland testing grounds on October 13, 1941. Became head of test firing section and developed special gun mount to facilitate recovery of test rounds fired. Returned to Company as junior geophysicist on October 16, 1945.

DICK MANEVAL—radio mechanic joined Department of Terrestrial Magnetism, Carnegie Institute on June 16, 1941. Was in charge of DTM shop which built models for VT fuse. Returned to Company on March 12, 1942, and is now head of Company's radio shop.

LEO BROUSSARD—senior geophysicist in Geophysics Research went to DTM on June 1, 1942, and later transferred to Johns Hopkins. Was in tube department, worked on microphonics and later on circuits and testing. Has resigned from Humble and is on research project at University of Texas.

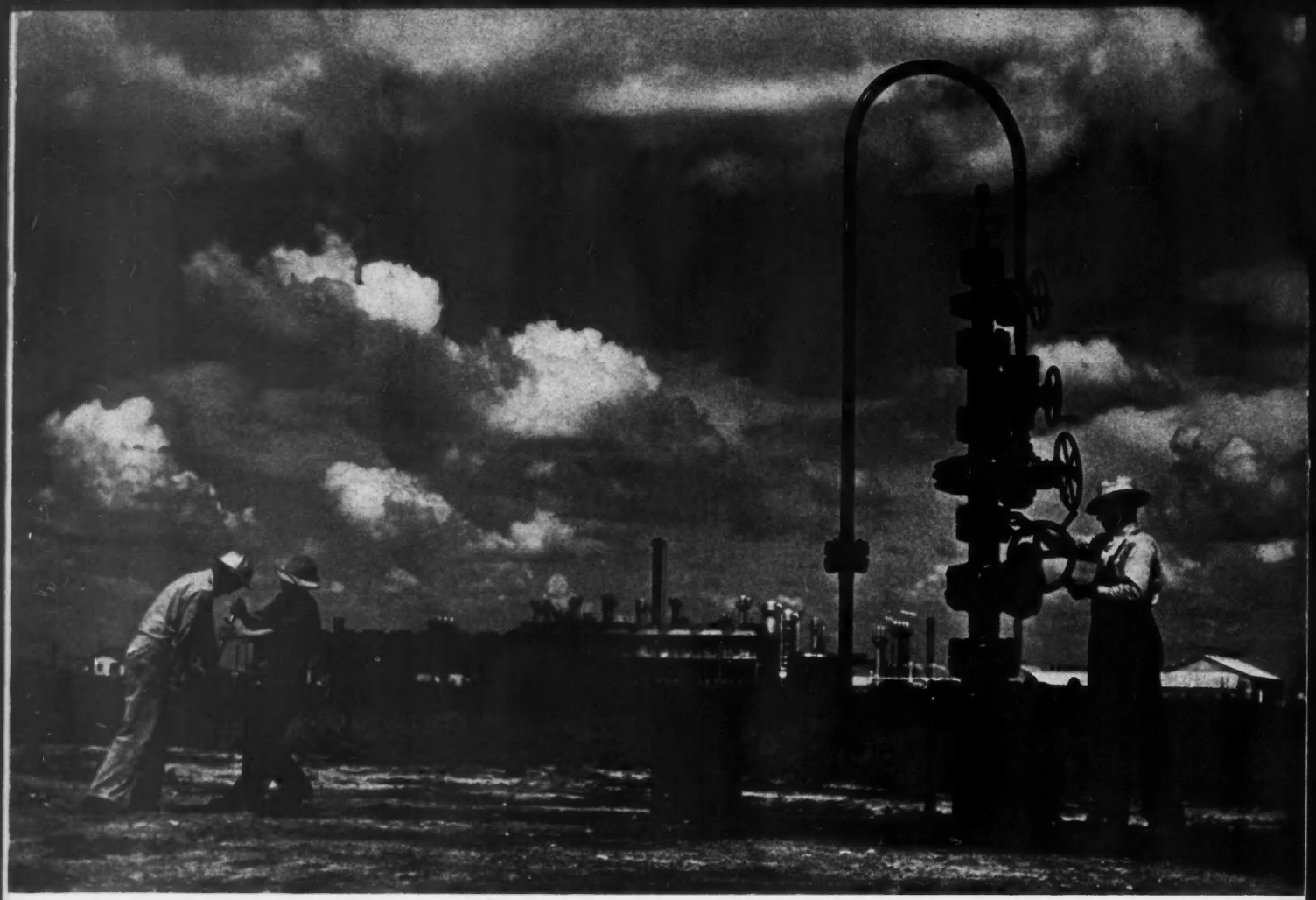
J. M. LOHSE—seismic computer in Geophysics Research joined others at Johns Hopkins on June 11, 1942. Worked on quality control and production problems. Has resigned to do similar work for Naval Ordnance Laboratory.

DR. L. G. HOWELL—went from Geophysics Research to DTM on September 3, 1941, later transferred to Applied Physics Lab, Johns Hopkins. In charge of testing tubes, developing method of recovering cannon ball for testing. Was liaison man with tube factory for short time, worked on trick switches, and on two other secret projects. Returned to Humble as research specialist on August 13, 1945, and has been requested to supplement Humble work by acting as consultant for Johns Hopkins Applied Physics Lab.

F. W. HUDSON—left Geophysics Research in November, 1942, to join M. A. Arthur at Carnegie Institute. Worked in safety devices, had charge of field office where safety devices were tested. Still on the job in Washington.

C. C. BIES—Engineer in Production Research left for Carnegie Institute on June 3, 1942. Did general research work on fuse and originated basic idea for self destruction device to insure destruction of shell if it fell as dud. Seven months in Washington, 3½ months at Albuquerque, New Mexico, on project. Returned as engineer in Geophysics Research on April 1, 1943.

JOHN BUSACKER—radio technician in Radio Shop departed for Johns Hopkins on June 15, 1941. Did general research work on fuses. Has resigned from Humble and is doing research work at Johns Hopkins University.



AN INJECTION WELL THROUGH WHICH NATURAL GAS UNDER HIGH PRESSURE IS RETURNED TO UNDERGROUND FORMATIONS

Natural Gas ☆ BURIED TREASURE OF THE GULF COAST

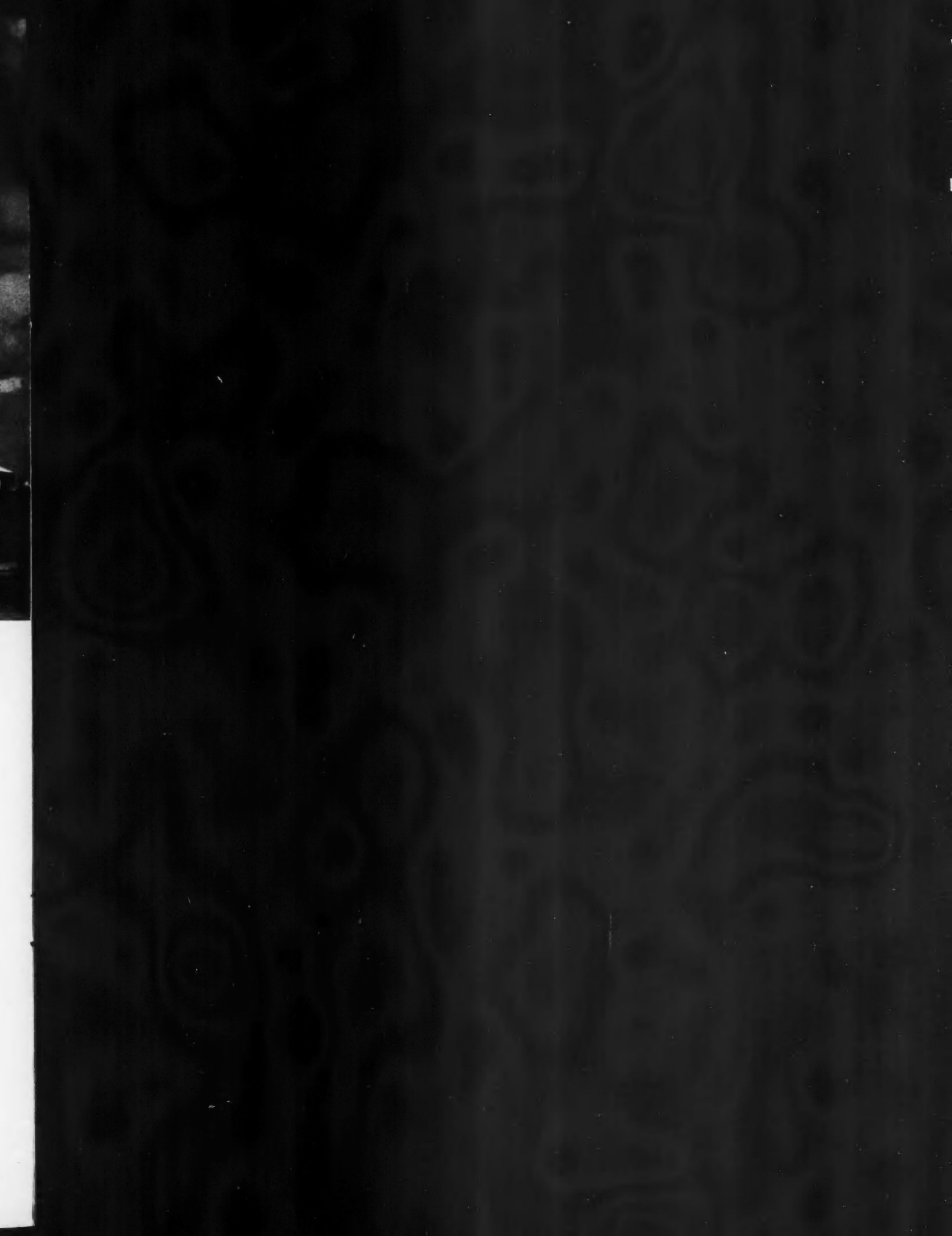
BY H. C. WIESS, *President*
Humble Oil & Refining Company

THE TEXAS and Louisiana Gulf Coast, comprising a strip about 100 miles wide extending some 700 miles from Brownsville to New Orleans, has come in recent years to occupy an important position in the natural gas reserves of the United States. Probably no other equivalent area in this country contains such a store of buried treasure in the form of oil and natural gas. Only the Panhandle-Hugoton area, stretching from Amarillo to Kansas, can compare in gas reserves, but it does not have comparable oil reserves.

The Gulf Coast now has proved reserves of over 45 trillion cubic feet of gas and 6 billion barrels of oil, representing 30 per cent of the reserves in the United States, which are about 150 trillion cubic feet of gas and 20 billion barrels of oil. The great reserves of this coastal area help to explain the fact that Texas and Louisiana have about 70 per cent of the nation's oil and gas resources.

Practically all of the important gas reserves in the Gulf Coast have been found within the past fifteen years, as the depth of wells drilled has increased steadily. The principal fields include Katy, Old Ocean, Pledger, and Sheridan in the Upper Texas Gulf Coast; Erath and Paradis in South Louisiana; and La Gloria and Agua Dulce-Stratton in Southwest Texas. Gas has been discovered in recent years more rapidly than it is being produced, with the result that there is a current surplus of supply. The large discoveries appear to be related to deeper drilling. As a general rule, pressure and temperature in oil and gas reservoirs increase with depth. These conditions are factors in the discovery of a high proportion of gas fields and oil fields with large quantities of gas as depth increases. Improved equipment and technology, which have made it economically feasible for the industry to drill deeper in recent years, will probably result in the discovery of additional important new gas fields in the Gulf Coast, indicating a very favorable outlook for gas reserves within the near future.

Much of the gas found in this area comes from the same reservoirs as oil and seems to have originated under similar conditions. The existence of such hydrocarbons in the liquid or vapor phase depends on the relative proportion of the



various constituents present and on the pressure-temperature conditions in the reservoir. Even strictly gas reservoirs, in which no liquids exist under conditions prevailing in the producing formation, usually contain some hydrocarbons that are condensed as liquids at atmospheric conditions. Such reservoirs account for the largest part of the coastal gas reserves. Important gas reserves are also found in the form of free gas caps immediately above oil accumulations. Finally, there is some dissolved gas contained within the oil in the reservoir, which gas is liberated as the oil is produced. It will be recognized from this that oil and gas are very similar in character and are frequently interchangeable to a large extent in modern chemical and refining processes.

Natural gas is known to most people simply as a fuel used in millions of stoves and heaters. Such gas consists almost entirely of methane and ethane, two hydrocarbons whose resistance to change from the vapor phase is indicated by the fact that they do not condense into liquid at atmospheric pressure until they reach —259° F. and —130° F., respectively. As it is produced from wells, gas is ordinarily a much more complex mixture, including varying amounts of propane, butane, pentane, hexane, and heavier hydrocarbons. Some of these hydrocarbons are extracted as liquids to be included in motor gasoline, while others are bottled under pressure in steel cylinders and used to provide a convenient gaseous fuel for consumers in isolated areas. The proportion of the components other than methane and ethane is generally small, and depends upon the source of the gas, the original reservoir conditions, and the extent of association with oil.

Gas is thought of primarily as a fuel, in spite of the varied use of some of its components, because the great bulk of it is used for that purpose. It is, of course, a premium fuel that is very convenient to use. It can be used in small quantities with low-cost equipment. It is extremely convenient for domestic use both for cooking and heating, since its use requires little or no attention on the part of the user. It is also used extensively for commercial and industrial purposes. In certain industrial uses it is indispensable, while in other cases, it is merely a substitute fuel used in place of oil or coal. Ordinarily, the choice between coal, oil, or natural gas for industrial use depends on their relative prices. Due to its convenience and suitability for special uses, natural gas should bring a higher price than other fuels for the same heat value. The normal economic forces of demand, if not interfered with, should tend to bring about the proper relationship of price that will reflect the premium value of gas.

Gas is also used as a raw material for the manufacture of numerous products. The largest requirement of this type is for making carbon black, which is essential in the manufacture of tires. The processes for manufacturing carbon black have been relatively inefficient, recovering only a fraction of the total carbon. A number of the plants built during the war employ new manufacturing processes that recover about 10 pounds of carbon black per thousand cubic feet of gas, compared with an average of only about 1.5 pounds from the older methods. Continuation of this trend will reduce the amount of gas needed for carbon black.

The newest and most spectacular use of some of the light constituents of gas is for the manufacture of chemicals. The hydrocarbons in natural gas, just as those of oil and coal, can be used to make a wide range of chemical products, including such things as synthetic ammonia, methyl alcohol, formaldehyde, and substances that can be used in plastics and synthetic rubber. While such uses are important, they can be supplied with a small fraction of the current gas production.

There is a potential use of natural gas that must also be considered; namely, the manufacture of liquid fuel from methane. Methane is very difficult to convert into liquid, but techniques have already been developed to manufacture synthetic gasoline and diesel oils from methane by chemical synthesis. Plant designs for such manufacture are being improved rapidly and it may not be long before these products can be made from natural gas at costs competitive with the products from crude oil. This is particularly true in view of the chemical products that can be produced incidentally, which may provide a substantial by-product revenue, thereby reducing the cost of the synthetic gasoline.

Natural gas transportation to consumers presents unique problems. Unlike other commodities, natural gas can be transported only by pipe lines. Furthermore, it must be sold as it is produced, for it cannot be stored in substantial amounts. Since the demand fluctuates seasonally, pipe lines must be built for peak loads. These circumstances combine to make the transportation of natural gas expensive. To move 6,000 cubic feet of gas from Houston to New York by pipe line, for example, costs about five times as much as shipping a barrel of crude oil, with the equivalent heat value, by tanker.

The limitation on methods of delivering gas to market and the availability of substantial supplies produced with oil have resulted in keeping gas low in price, considering its fuel value. In order to produce certain liquids from gas reservoirs, which could not be done legally unless the gas was sold or returned to the reservoir, some operators have sold gas at less than one cent per thousand cubic feet. Such sales have a depressing influence on the market price in adjacent fields. Consequently, gas prices recently have generally been between 1 cent and 5 cents for a thousand cubic feet, and have averaged 2.5 cents in Texas. These prices, which are lower than prevailed twenty years ago, are inadequate, since they mean an average realization of only 15 cents for gas with the same fuel value as a barrel of crude oil, which sells for $1.20 at the well. The spread between these similar fuels is too great. Within the next few years, it must be reduced by advancing prices until natural gas in Texas generally sells for 10 cents or more for a thousand cubic feet.

Gas prices have an influence on the future of reserves in that they affect conservation of presently known supplies and govern exploration for and development of additional fields. Im-

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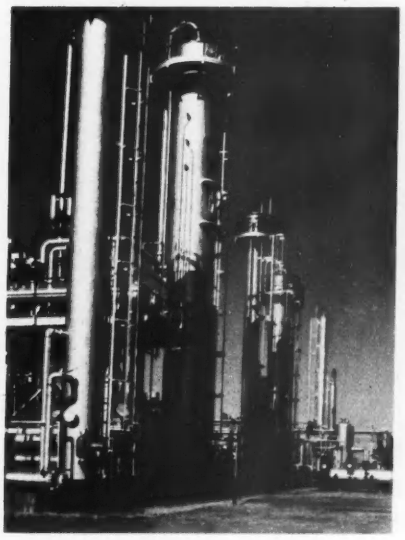
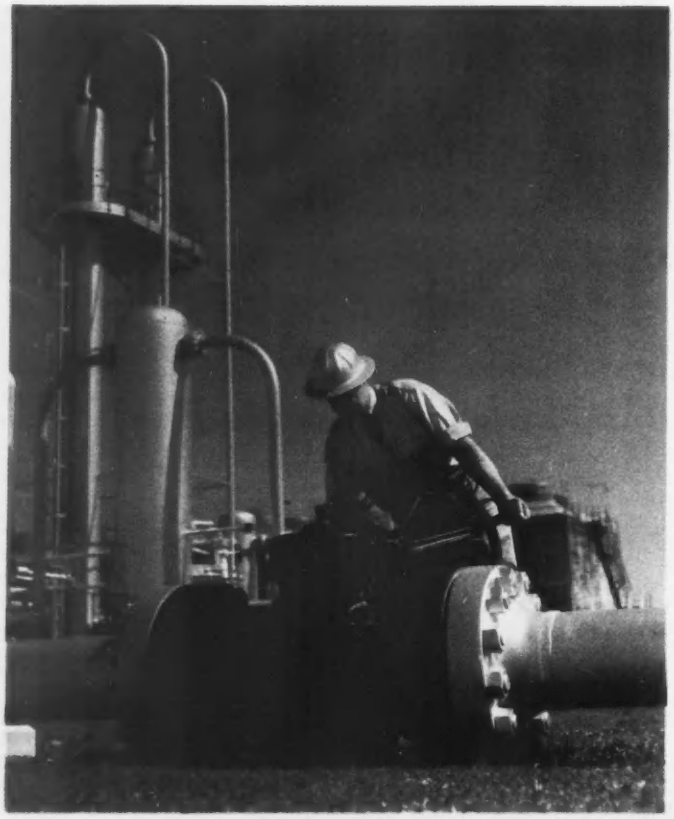
THE FUNCTIONAL BEAUTY of gleaming towers rising against a Texas sky is typical of gas plants in the Gulf Coast region.





KATY GAS CYCLING PLANT

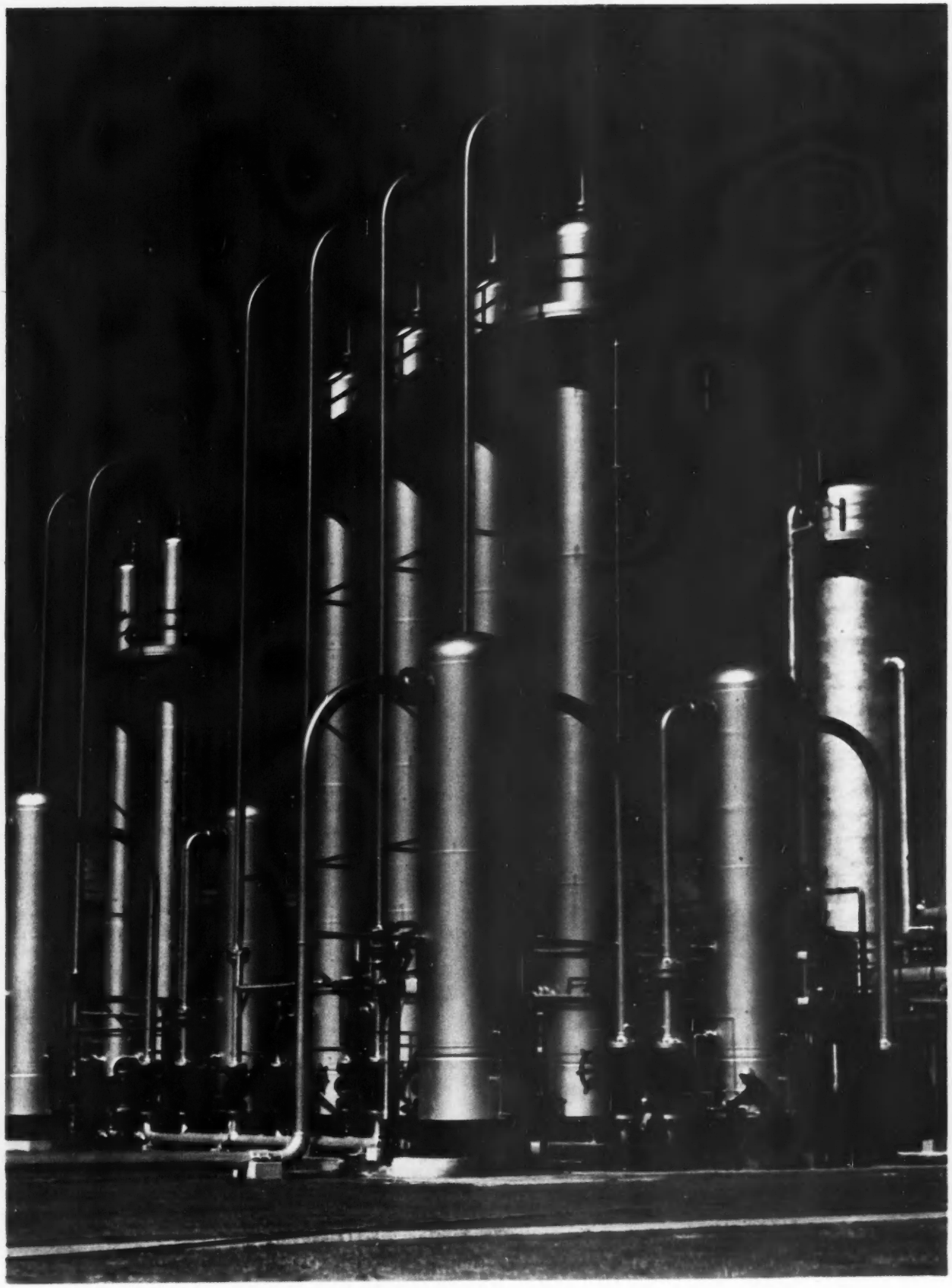
This plant, located 30 miles west of Houston, is designed to utilize most completely the latent energy of natural gas. It is the result of arrangements begun in 1939 and culminating in a joint agreement of 35 separate companies whereby the plant was constructed by Humble and is operated by Humble for the joint interests.

The first unit of the plant was put in operation in January, 1943, and construction was started on the second unit almost immediately. The second unit began operating in October 1944. A third unit consisting of fractionation equipment was completed in August 1945.

Gas from 31 wells in the amount of 450 million cubic feet daily is passed through an absorption system which removes an average of 14,000 barrels per day of petroleum products, principally gasoline. More than 80% of the gas, stripped of its recoverable hydrocarbons, is pumped back into the ground.

Cycling simultaneously conserves the dry gas for future use and makes available to present day users the petroleum products contained in the gas. This is real conservation.

THE PICTURES: Turning a mammoth valve (top, left) on a high-pressure gas line. A general view (below) of Katy cycling plant. The gleaming towers in the large picture at the right are part of the absorption system.



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proved prices will hasten progress in conservation of casinghead gas. For many oil fields, the expense of collecting gas produced in small quantities, in compressing such gas to the high pressure required for transmission, and in making delivery to main lines, would amount to more than 5 cents per thousand cubic feet. At present, proper economic incentives for the fullest utilization of gas are frequently lacking. As prices improve, an increasing proportion of casinghead gas will be utilized for fuel.

Sound progress in gas production and use requires a balance between supply and demand. Increasing demand, which is being made effective by numerous expanded uses, and the steady progress being made toward conservation in the field, will help to bring about normal adjustments. Artificial restraints and controls on gas use and prices are not to be desired. The proper adjustments will best be found in the competitive atmosphere of free enterprise. Unnecessary regulations by government agencies can only retard and hamper satisfactory developments in this direction. There should be no regulation of the field price of gas, either by state or federal government agencies.

The temporary abundance and favorable outlook for the discovery of natural gas should not be allowed to cloud the need for gas conservation. Although large in relation to immediate needs, and probably adequate for several generations, gas resources have a relatively limited life. It is important that they be conserved with the same care as oil reserves, for they are already as important in terms of fuel value as the known oil reserves. They may become even more important, relatively, as oil reserves are depleted by high demands in the future.

One of the most significant gas conservation measures has been the development since 1938 of cycling plants. These plants process gas for the recovery of liquid hydrocarbons, and return all or most of the dry residue gas to the reservoir, where it serves to maintain pressure and increases the recovery of liquid hydrocarbons, in some cases, as well as to store the natural gas for future use. The first cycling plants were completed in Texas in 1938. They represent an ideal method of securing some production and income currently from a gas field, while avoiding waste and the undue pressing of gas upon the market at low prices. The Texas-Louisiana Gulf Coast now has 25 cycling plants processing about 1,800,000,000 cubic feet of gas daily and recovering about 58,000 B/D of liquid hydrocarbons. These plants return some 75 per cent of their residue gas to the reservoir for future use.

Progress in conservation of gas, as in the case of oil, has been carried out by cooperation of the industry with state regulatory agencies under the conservation laws of the states. The Texas Railroad Commission and the Louisiana Conservation Commission have taken cognizance of the need for gas conservation and have acted to encourage such conservation through their regulations. The Gulf Coast area in particular, has witnessed a remarkable expansion in cycling operations and the return of gas to the reservoirs. The two largest cycling plants in the country are in this area at the Katy field in Waller County, Texas, and the Erath field in Vermilion Parish, Louisiana. It is anticipated that progress will be even more rapid now that the men and materials are available to take advantage of the best conservation practices. Committees of engineers and operators appointed by the Texas Railroad Commission have recently completed exhaustive studies of gas conservation. Their reports contain far-reaching recommendations for a comprehensive program of gas conservation involving the enactment of some needed legislation and the diligent application of cooperative efforts toward waste prevention.

Progress in gas conservation has been somewhat obscured recently because of the amount of gas flared from oil wells during the war. The rapid expansion of petroleum production in Texas from 1,385,000 barrels daily in 1941 to 2,200,000 at the war peak brought about a corresponding gain in gas produced with oil. The impossibility of securing materials and manpower to conserve this abnormal production resulted in more gas being flared. This was inevitable under war conditions, but must not be considered typical of ordinary operations. A good deal of the flaring of gas associated with oil has already disappeared as oil production has dropped back toward normal. A large part of the remaining flares will disappear within the next few years as natural gasoline and cycling plants are built to recover liquid hydrocarbons and to conserve gas for sale or future use through return to the reservoir. A number of companies have announced extensive gas conservation programs that will be started soon. Humble Oil & Refining Company alone has announced new projects which will cost $6,000,000 and conserve 110,000,000 cubic feet of gas daily in the Gulf Coast.

The future outlook for oil and gas production in this country is often presented to the public as being highly unfavorable, because the known reserves reported appear to be sufficient for only twenty or thirty years. Such comparisons, made by those not familiar with the industry's accepted practice, completely overlook the potential supplies to be discovered in the future. The oil industry always speaks conservatively of available resources by reporting only the known quantities that can be recovered from structures already proved and developed. Past experience has shown that we continue to find and produce oil long after pessimistic estimates said we would exhaust our reserves. The industry is confident that considerable reserves of oil and gas still remain to be found and that they will be found under suitable economic conditions.

The effective conservation developed in oil production clearly demonstrated its value during the recent war by making possible production of the tremendous quantities needed for the global conflict. The same basic principles of conservation are now being extended rapidly to natural gas. The value of gas conservation is now widely recognized and producers generally are working diligently to bring about the maximum economic utilization of gas. They recognize the increasing value of this important resource, and are prepared to conserve it for future use if adequate markets are not immediately available. The public interest is being advanced by the efforts of Texas, Louisiana and other states to bring about effective and sound conservation in the simplest manner possible. These efforts should not be hindered by new and untried regulations, but should be encouraged instead. Consumers, likewise, must realize that conservation is to their interest, for they stand to benefit not only from the supplies of gas saved by waste prevention, but also from reasonably priced fuels over a long period of time.

The progress being made in gas conservation by the producers and state regulatory agencies is encouraging. With full industry effort, appropriate legislation, and wise administration, the remaining problems can be solved promptly. The Gulf Coast can look forward with confidence to a long period of sound development and production of its natural gas resources.

IN THE SERVICE

☆ ☆ ☆ ☆ ☆

WHILE the return of Humble veterans to their old jobs with the Company has speeded up considerably in recent weeks, there is still some interesting news about others who continue to serve abroad and here at home.

Lieut. Andy V. Brannon writes from Tokyo Bay that he expects to be home in a matter of weeks after 38 months of almost constant sea duty aboard destroyers and six months with famed Task Force 38 making strikes against the mainland of Japan. His ship was one of the first to enter Tokyo Bay on August 29. A rotary helper in the Production Department at Colorado, he went into the Navy April 2, 1942.

Maj. C. E. Long, Jr., geologist in the West Texas Production Division Office in Midland before going into the Army in April, 1942, has returned from the European Theater of War, where he went through four major battles. He has reported back to Ft. Bragg, North Carolina, after a leave at home.

Home on leave recently was *Navy Lieut. D. H. McKinney*, chief draftsman in the Pipe Line Engineering department before going into the Navy August 26, 1944. He is engineering specialist, officer in charge of property section of the Detroit Naval Inspection District, and reported back to Detroit.

A news release from Northern Luzon, Philippines, shows that *Capt. John F. Ross*, civil engineer in the West Texas Production Division Office before going into the Army July 12, 1942, is now battalion commander of three engineer companies. Before the cessation of hostilities in that section of the Philippines he had the experience of firing a Japanese artillery piece at the enemy. Working in the Northern Luzon mountains, his outfit was suddenly fired upon by the Japs. In the same vicinity was a Filipino Guerrilla Infantry unit with captured enemy artillery. Captain Ross manned one of the pieces, and, with the Filipino unit, opened fire upon the Japs, who fled further into the mountains.

Vice President David Frame welcomes back S/Sgt. Albert Carpenter who returned several weeks ago after more than three years in Jap prison camps. Sergeant Carpenter was in the Production department at Bayou de Glase, Louisiana, before donning the uniform early in 1941. His father is F. L. Carpenter, district superintendent at Raccoon Bend.

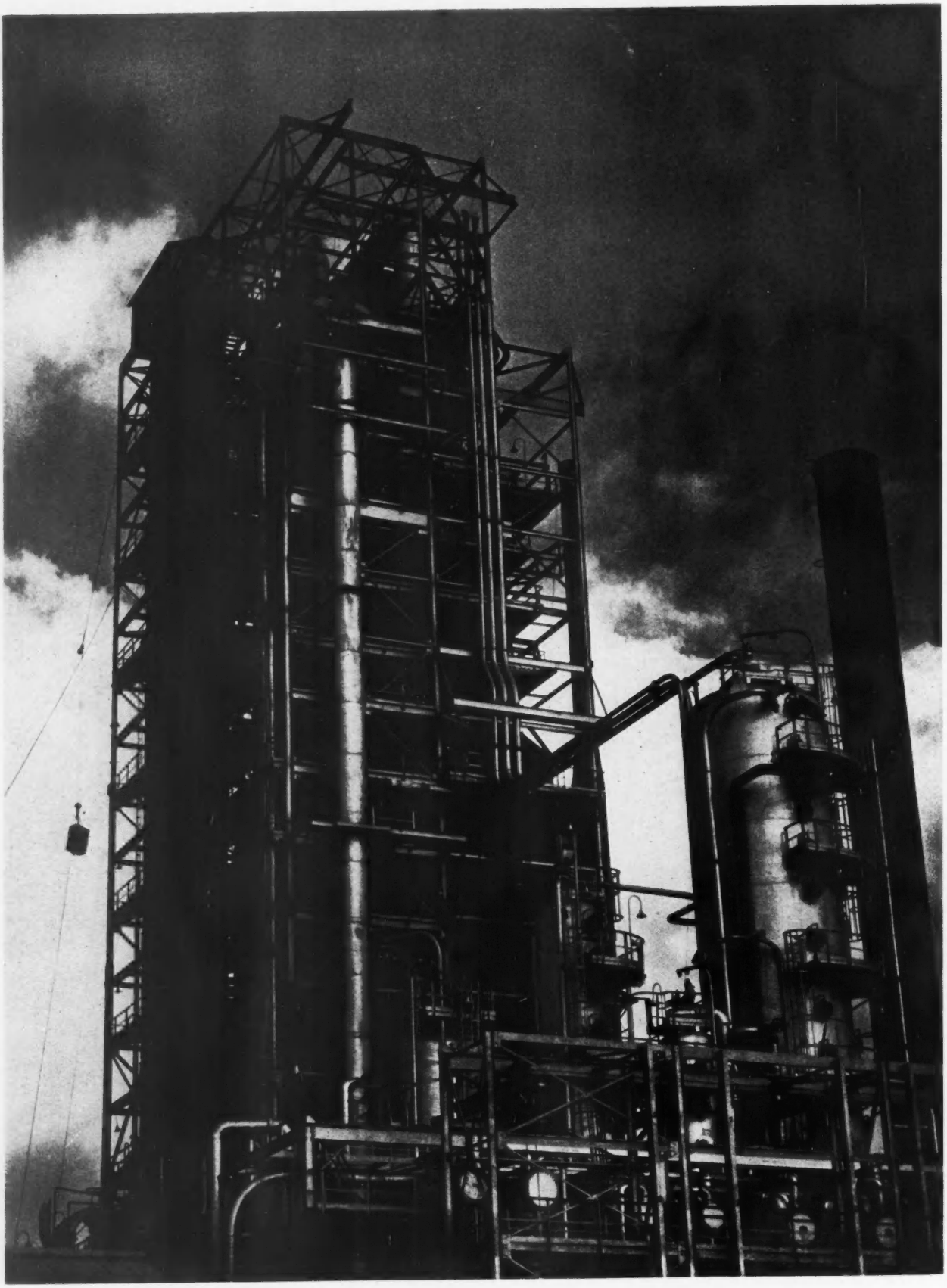
From Caserta, Italy, comes notification that *Lieut. Col. Jack S. Toler*, civil engineer in the Bayou Sale District of the Production department before going into the Army February 13, 1942, has been awarded the Legion of Merit. The award came for "performance of outstanding service as assistant chief of Petroleum Section, Services of Supply, Mediterranean Theater of Operation, U. S. Army." He was commended for his assistance in the construction of military pipe lines in Sicily, Italy, and Southern France.

Another Humble man receiving commendation for his work on the military pipe lines in Europe is *M/Sgt. James C. Guyton*. His "experience and general know-how" were termed by his commanding colonel as "invaluable to the Military Pipe Line Service in its task of supplying gasoline to the armies in France, Belgium, and Germany." He was a roustabout in the Sand Hills district of the Production department before going into the Army August 31, 1943.

CAPT. JOHN F. ROSS

LIEUT. D. H. McKINNEY

M/SGT. JAMES C. GUYTON



Turnaround..

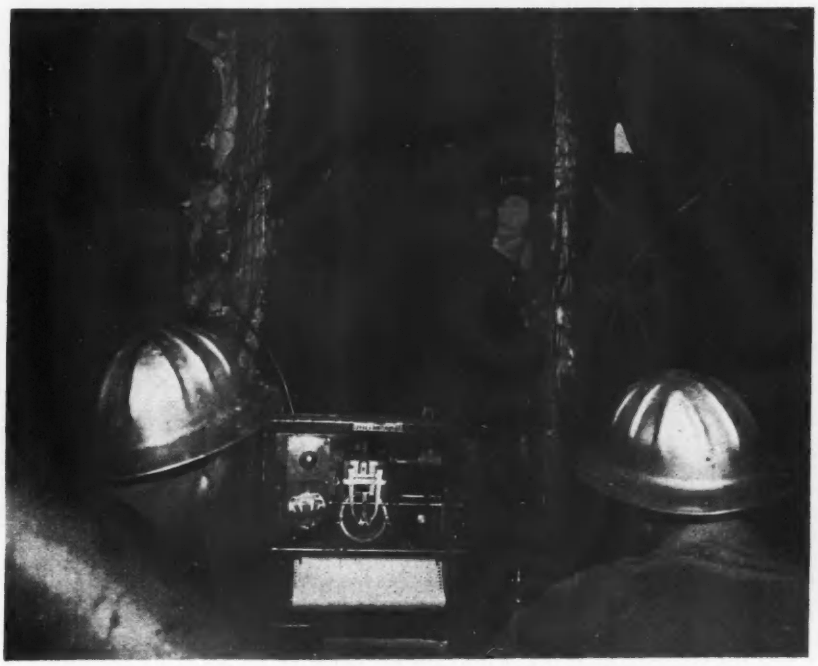
BUILD a roller-coaster as high as a 20-story office building. Make it a big, sprawling one. Use more steel than is in the cruiser *Houston*, and spread it over a city block. Then construct a vertical chute to the bottom, bend it, and bring it back to the top. Now send a series of ten-ton trucks down this vertical track with velocity enough to complete the round trip in one minute. Keep these trucks in operation 24 hours a day.

Incredible, isn't it? Yes, for a roller-coaster, but not for a catalytic cracking unit in a modern refinery. The No. 1 Fluid Catalytic Cracking Unit at Humble's Baytown refinery is 260 feet high, contains 8500 tons of steel, and circulates catalyst and oil at the rate of ten tons per minute. Originally designed for a capacity of 13,800 barrels per day, the unit has been operating on a stepped-up schedule of 24,000 to 26,000 barrels per day. As you stand watching it, the cracking unit processes nearly ten gallons of oil every time your heart beats. In a single day, it produces enough components for the aviation gasoline used in a thousand B-25 medium bombers.

Such equipment, of course, cannot continue to operate day and night indefinitely under these strenuous conditions. Calls for production in excess of designed capacity made these conditions even more critical. For increased production, more catalyst must be used; more catalyst demands more air pressure from the blowers; increased amounts of circulating catalyst lead to faster erosion of equipment. So, like all other refinery units, the great "cat cracker," as the industry knows her, must be brought down periodically for general inspection and repairs. Refinery men call this down-time period a "turnaround."

On October 6, Baytown's cat cracker No. 1, having been in nearly continuous operation since April 25, was pumped out for a turnaround. As usual, eroded tubes in the reactor cyclones were pri-

PLANNING WORK for hundreds of craftsmen on the job is the task of engineers, inspectors, and supervisors as the turnaround progresses. Below, instrument men keep a close watch on a pyrometer recording temperature during stress relieving of a new flange on a 72-inch line.



RIGGERS GIVE a load of material a long ride to the top of the giant Cat Cracker as turnaround activity gets under way.

marily responsible for this lost time. To clarify that statement, cyclones act as separators which remove catalyst from oil following the cracking process. Catalyst-and-oil mixtures enter the cyclone tubes at high speed. Oil goes up; catalyst comes down into the regenerator, where accumulated carbon is burned off. In the separation process, erosive and abrasive action of the catalyst scrubs cyclone tubes mirror-bright and eventually wears them out.

Replacement of worn cyclone tubes with new ones was only part of the job, however. As soon as the last barrel of oil was pumped from the unit, hordes of skilled workmen in all crafts swarmed over the skyscraper to begin work on a five months' accumulation of repairs and replacements.

Metal inspectors and engineers designated which vessels, pipes, pumps, and other equipment needed attention. Under direction of mechanical superintendents and other supervisory personnel, the various crafts began work at once. As soon as furnaces had cooled sufficiently, brickmasons went inside to check on brickwork. Tube cleaners drilled out carbon deposits in furnace tubes. Boilermakers began repairing large drums and vessels. Insulators stripped layers of asbestos from pipes. Pipefitters unbolted flanges from these stripped lines, and riggers, using heavy cranes, lifted out the lines. Burners cut off faulty sections of pipe, and welders put in new sections or welded on new fittings.

Machinists and their helpers dismantled pumps and compressors and installed new rods, seals, and packing. Carpenters, meanwhile, were using a small forest of lumber to build scaffolds around normally inaccessible portions of the unit. Leaking valves were removed and sent to the reclamation shop for repacking and general overhauling. Electricians strung new wires, repaired lighting fixtures, and inspected other electrical equipment. Painters, raised on scaffolds to dizzying heights, applied a fresh coat of paint to towering smokestacks. Laborers, their wheelbarrows loaded with debris from the day's work, scurried here and there.

While the unit was down, a number of ideas proposed to increase capacity or give smoother operation were put into effect. These ideas, originating with engineers, operators, and mechanics, included relocation of control instruments, installation of new equipment, or rerouting of existing facilities.

This particular turnaround presented some special problems in stress relief. When certain alloys containing chromium, nickel, molybdenum and other elements are welded or bonded together, stresses and strains in the metal are set up as the weld cools. By carefully controlled heat treatment of the weld and surrounding metal surfaces, the molecular and crystalline structure of the metal is rearranged in such manner that these stresses and weaknesses are relieved. Under changing temperatures of operation, lines and other equipment should expand and contract as evenly and smoothly as possible.

Ordinarily, stress relieving is done at the welding shop's furnace. This time, however, a giant 72-inch line, large enough for a tall man to stand in without stooping, needed a new flange connection. It was impracticable, of course, to remove the line, so a furnace was built around it. A circular system of gas and air lines was piped around the welding area, and fires were lighted. Keeping careful check with an instrument re-

PROCESS operator checks tubing erosion in one of reactor cyclones.

WELDER WORKS on breather valves at regenerated catalyst hopper.

cording temperature, instrument men brought the preheat temperature of the area up to 500 degrees Fahrenheit and held it there for 137 consecutive hours. Meanwhile, welders working in shifts inside the big line applied the weld. When the welding job was completed, the actual stress relieving began. At the rate of 300 degrees per hour, temperature was brought up to 1250 degrees and held for three hours. Then the temperature was lowered to 600 degrees at the rate of 200 degrees per hour and the metal allowed to cool from that point to atmospheric temperature. Thus, 145 hours—more than five days—were spent in stress relieving this one line. Thirteen similar jobs were done on lines from 60 inches to four inches in diameter.

After a month's work, the cracker was ready for a test run. Three separate shifts of trained men, working around the clock so that no time would be lost, did a tremendous repair job in record time. On November 6, after hundreds of men in all skilled crafts had worked a total of 82,798 man hours, the cat cracker was brought back on stream.

RIGGER DIRECTS lifting of an exchanger tube bundle upward. Insulator (center) deftly cuts and fits sections of insulation around hot oil lines. Machinists give compressors in light ends service a complete, careful overhauling.

HOLD THAT FILM

Pipe lines and tank bottoms protected from corrosion by thin film of hydrogen, electrically created

By R. A. BRANNON
Senior Corrosion Engineer

The story is told of an early American settler, wrapped in skins and furs against winter's chill, who asked a scantily clad Indian if he were not cold. The Indian looked stolidly at the settler for a moment and countered with the question: "Your face cold?"

A little surprised, the settler explained that his face was accustomed to the weather and that it felt quite comfortable. To which the Indian replied pridefully: "Ugh, me face all over."

The simple fact, of course, was that the Indians, through generations of exposure, had developed a resistance to cold. Some invisible something, some protective layer served them unfailingly.

Now the comparison between the human body and an ordinary steel pipe may appear remote, but it is an invisible protective coating that draws the two close together in this case. For pipe line corrosion engineers have discovered that an invisible continuous film of hydrogen in many cases is a better protective against pipe line corrosion than the hot asphaltic coating and felt wrapping conventionally applied.

But hydrogen is a gas, the lightest one there is at that. So how can a thin film of it be more effective than the heavy coatings which have been in use for so long? The secret is in the word *continuous*, for a buried pipe which has a continuous coating of hydrogen simply cannot corrode.

Natural questions which arise are: Where can this wonderful coating be obtained? How can it be applied? Is it being used?

Like the air and the rain, it can be had for the taking; it can be applied without disturbing underground pipe lines; and it is being used. It all seems quite wonderful, but actually the basis for it all is a little more involved than the mere statement of its effectiveness.

This protective invisible film of hydrogen is the natural result of electrochemical action in the ground. When a direct electrical current passes from a water solution into a metal, part of the hydrogen of the water is plated out on the metal. In the case of pipe lines, the hydrogen is plated out of the soil water and onto the pipe, a phenomenon which occurs naturally when the pipe is exposed to soil moisture. The trouble with this naturally deposited film is that it is not continuous, for as pipe lines pass through a variety of soils differing in water content, texture, and electrical sensitivity, battery cells are set up which cause a flow of electric current from the pipe into the soil at some locations and back into the pipe at others. The current which leaves the pipe takes iron into solution with it, and it is this theft which causes troublesome corrosion.

Pipe lines are involved, therefore, in a natural electrochemical action in which some portions of them are corroded and other portions are not, Figure 1.

It will be noted that parts of the electrical paths are through the metal of the pipe and parts are through the solutions in the soil. These circuits are called electrochemical cells. These two electrical conductors are very different in character and the chemical change takes place at the surface of the metal where the current enters or leaves.

It might be said that the steel appears reluctant to carry the current and charges admission by requiring a deposit and is so glad to get rid of the current that it refunds the deposit by allowing the current to take iron into solution with it. The amount of iron dissolved is electrochemically equal to the amount of hydrogen deposited, so that the current gets free passage after all. The hydrogen deposited on the metal tends to insulate it from the solution in which it is immersed, and

CATHODIC PROTECTION PROVES SUCCESSFUL ON 62 TANK BOTTOMS AND 53 MILES OF LINE AT WEBSTER TANK FARM.

thus a resistance is set up to the further flow of current. It is fortunate for the users of buried steel structures that this is true because the initial corrosion rate is extremely high. Innumerable tiny cells are set up immediately upon immersion of the steel in the solution. As the corrosion proceeds, the stronger cells overcome the weaker ones by completely covering them with a hydrogen film.

Areas where the current enters the pipe and hydrogen is deposited are said to be "cathodic," and areas where the current leaves and iron is taken into solution are said to be "anodic." Due to the electrical resistance of the hydrogen film, the natural tendency is for the cathodic areas to grow and the anodic areas to shrink. This reduction of the anodic areas causes the corrosion to occur at concentrated points and results in the pitting action which is familiar. These pits penetrate the pipe and cause failures even though the actual weight of metal lost is negligible. Sometimes changing conditions cause even the anodic areas to become covered with a film of corrosion products or other substances which resist the flow of electric current, and corrosion of the whole structure is reduced to a negligible amount. Usually, however, certain spots remain anodic and corrosion continues until failure occurs.

It is fruitless to speculate on whether the flow of current causes the corrosion or the corrosion causes the current to flow. The fact that one cannot occur without the other provides us with a way to stop the corrosion by controlling the flow of current.

The method, known as cathodic protection, consists of causing an electric current to flow from the soil to the pipe at all points where they are in contact, thus covering the exposed pipe with a continuous film of hydrogen. There are numerous secondary reactions which follow the deposition of hydrogen and which aid in preventing corrosion. It is accomplished by connecting the pipe to the negative terminal of a source of direct current. The positive terminal of the current source is connected to a "ground bed" consisting of scrap pipe or other metal or carbon buried in the ground. The current flows to the ground bed and into the soil, through the soil to and into the pipe, along the pipe to the negative connection and back to the current source to complete the electrical circuit. This circuit is illustrated in Figure 2. The ground bed is corroded by the current passing from it into the soil and is consumed so that it must usually be replaced every few years. In effect the corrosion is transferred from the structure being protected to a separate mass of material whose destruction can do no harm.

Almost any source of direct current may be used. One of the most spectacular and interesting ones is the wind-driven generator. Many people have been puzzled by the appearance of isolated windmills on high towers that pumped no water and apparently charged no radio batteries nor did any other useful work. While the current obtained from these generators is free in that no fuel or outside power is required to operate them, their output is limited and extremely variable. Even in the windiest areas, these mills are idle a large portion of the time. One of the most dependable and most widely used sources of current is the rectifier, which converts the alternat-

ing current available from any power line to direct current. Rectifiers can be made with no moving parts, or with only a fan to keep them cool, so that they require relatively little attention. The principal hindrance to their wider use is that power lines are required to serve them. Some gas companies use gas engine driven generators. Since the fuel can be taken from the pipe line being protected, this is a fairly satisfactory method but even these companies usually prefer to purchase electric power and use rectifiers where they can because of the trouble encountered in maintaining moving machinery.

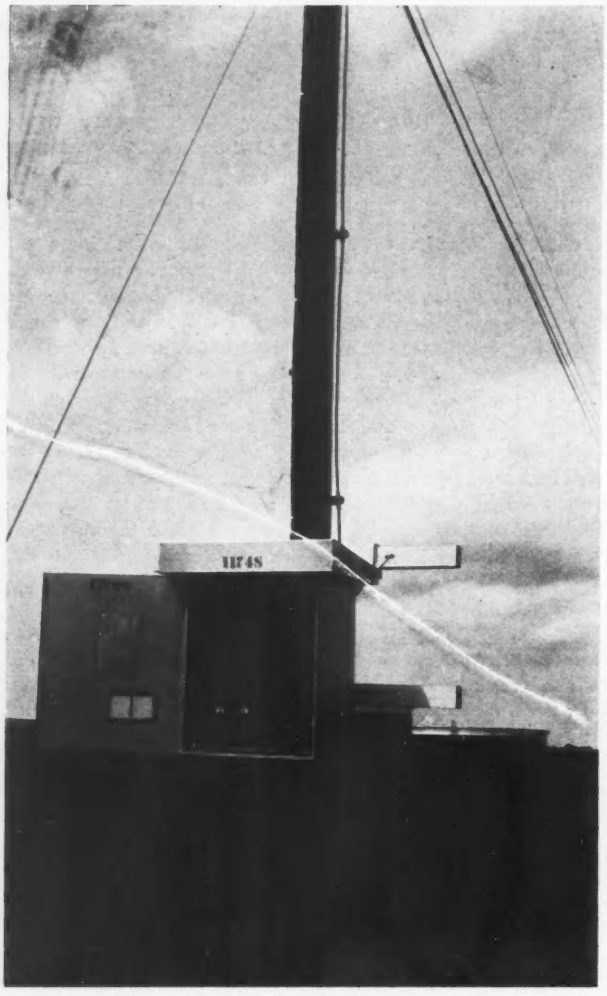
Another and different method of supplying cathodic protection current is by means of galvanic anodes. When pieces of such metals as magnesium, aluminum, or zinc are connected to pipe lines by means of wires and are then buried in the ground near the pipe, they corrode and discharge current to the soil. The current flows to and into the pipe, along the pipe to the wires and thence to the anodes, thus making the circuit complete, as all electrical circuits must be. These anodes have many advantages, one of which is that the whole structure is covered with earth, thus reducing the danger of theft and offering no targets for playful hunters. Other advantages are that no outside power is required and they can be placed exactly where they are most needed. A disadvantage is that only limited amounts of current are available from them and metals which are expensive compared with scrap iron, are used up in the process. Considerable use of these anodes has been made already and they are at present in a stage of intensive development.

Humble Pipe Line Company purchased and installed eight wind-driven cathodic protection units in 1936 and 1937. In 1939 three motor-generator sets and fourteen rectifiers were installed on pipe lines. A 13,200 volt high line twenty-five miles in length was built to supply power to these units. A unit consists of the source of direct current, the ground bed, and connecting wires or cables. At present, one of the wind-driven generators and the three motor-generators are still in service. There are now sixty-three rectifiers in service protecting pipe lines and tank farms at various locations from the Gulf Coast to the Panhandle and plans for the installation of many more are under way.

Outstanding success has been achieved at Webster Station where the under side of sixty-two tank bottoms and twenty-eight miles of tank farm lines plus about twenty-five miles of the incoming and outgoing pipe lines have been protected from soil corrosion since 1941 by the use of about a thousand amperes of cathodic protection current. Pit hole leaks were occurring on the tank farm lines at the rate of seventy-seven a year. Since the beginning of 1938, the rate has fallen off so that only four leaks occurred during 1944 and only one during the first nine months of 1945. It will take a long time for the protection afforded the tank bottoms to become apparent, but the reduction of corrosion on the tank farm lines is already quite impressive.

Most departments of Humble have made some use of cathodic protection. The Production Department has under protection a steel drilling barge used for drilling wells in Galveston Bay and other coastal waters. About twelve oil wells have magnesium anodes placed around them to furnish partial protection to the well casing. Sucker rods in oil wells have also had pieces of zinc attached to them to prevent corrosion.

The Gas Department has a larger proportion of its properties under cathodic protection than any other. Its entire Tom-



POLE-MOUNTED rectifier at Webster Station which changes alternating current to direct current, essential to the process. Figure 1, below, shows natural electro-chemical action in which pipe lines are involved.

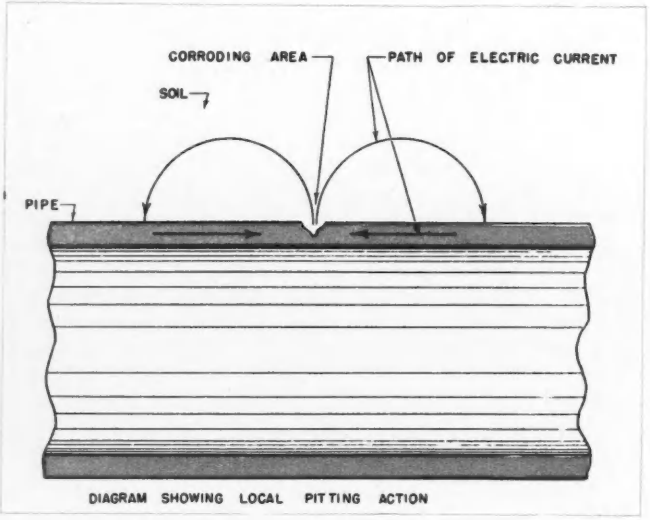


DIAGRAM SHOWING LOCAL PITTING ACTION

ball Natural Gas System, consisting of 225 miles of pipe lines varying in diameter from 3½ to 10 inches, is being protected by eight rectifier units. One rectifier unit in the Pledger Field protects eight miles of eight inch pipe and ten miles of three inch pipe. All parts of the Katy Gasoline Plant that are in contact with the soil are cathodically protected by five rectifier units. The ground beds at this plant are made of carbon rods and graphite rods. These rods are made especially for cathodic protection purposes and are designed for use where scrap iron or steel is not available or cannot conveniently be used. This Department is in the enviable position of having mostly new, well-coated lines and structures so that they can use cathodic protection to keep corrosion from starting rather than to stop it.

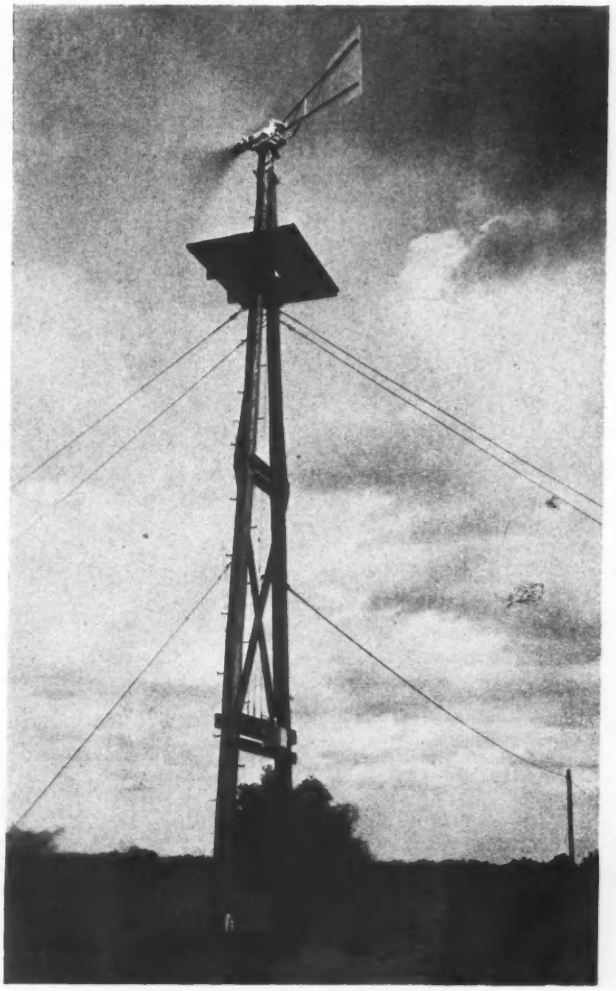
The answers to the questions concerning the method of obtaining and applying this marvelous coating and the use Humble is making of it all indicate that it is without equal and without flaw. But there must be some limitation to its use; otherwise Humble Pipe Line Company with more than 5000 miles of trunk pipe lines and with more than 51,000,000 square feet of tank steel in contact with the ground and with additional thousands of miles of field and station lines would have more than sixty-seven units in operation. Other departments of Humble would also make more use of it.

The limitation is that, under some circumstances, the film is difficult to maintain. Oxygen combines readily with the hydrogen to form water again. Thus in sandy, well drained soils where the oxygen of the air can readily penetrate to the pipe, the amount of current required for protecting poorly coated pipe would be great and power costs might be prohibitive. By the nature of this type of corrosion, the first cathodic protection current goes to complete the hydrogen film on the surfaces that are already cathodic and that are not corroding. Since these surfaces usually represent 90 per cent or more of the area of the structure, it is evident that current must be supplied to large areas where it is not needed in order to get it to the anodic areas where it will do some useful work.

Pipe lines that have protective coatings on them are easily protected because the pipe comes into contact with the soil and soil water only at places where the coating is faulty. The area of metal exposed is usually small and little current is required for cathodic protection. A combination of protective coating and cathodic protection is therefore effective and economical.

For new construction, there seems to be little doubt that good protective coatings should be used and cathodic protection applied if necessary. In the case of existing lines whose reconditioning and coating would be expensive and whose cathodic protection without reconditioning would be expensive also, an economic balance must be made. The science of cathodic protection is so new and changing so fast that the point of balance is sometimes hard to determine.

It is certain that cathodic protection will be more and more widely used and that more corrosion engineers will be going out with their potentiometers, ground resistivity testers, non-polarizing electrodes and other equipment to measure metal to earth potentials, soil resistivities, and other electrical and chemical values by which they decide how much current is needed and where and how it can be applied most effectively. It is equally certain that there will be installed more and more of these cathodic protection units which one pipe liner very simply and aptly described as "rust pumps."



WIND-DRIVEN direct current generator of the type used where no electric power is available. Figure 2, below, shows operating details of the cathodic protection system as employed by Humble Pipe Line Company

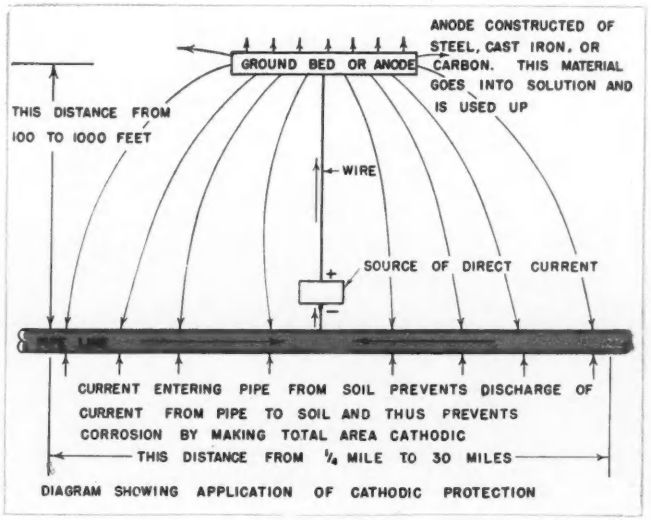

ANODE CONSTRUCTED OF STEEL, CAST IRON, OR CARBON. THIS MATERIAL GOES INTO SOLUTION AND IS USED UP
GROUND BED OR ANODE
THIS DISTANCE FROM 100 TO 1000 FEET
WIRE
SOURCE OF DIRECT CURRENT
+
−
CURRENT ENTERING PIPE FROM SOIL PREVENTS DISCHARGE OF CURRENT FROM PIPE TO SOIL AND THUS PREVENTS CORROSION BY MAKING TOTAL AREA CATHODIC
THIS DISTANCE FROM ¼ MILE TO 30 MILES

DIAGRAM SHOWING APPLICATION OF CATHODIC PROTECTION

Research Insurance

Patent group safeguards employee ideas and inventions originating in laboratory, shop, and field

AMERICA holds a position of leadership among the nations of the world today largely because from American shops, laboratories, offices, and fields consistently have come new ideas, new tools, new materials, new techniques. Free, imaginative people have created the new and better things to make life better for themselves and their fellow men, and other free people have pooled their resources in business ventures which have made possible the economical mass production and distribution of these better things to millions in all walks of life.

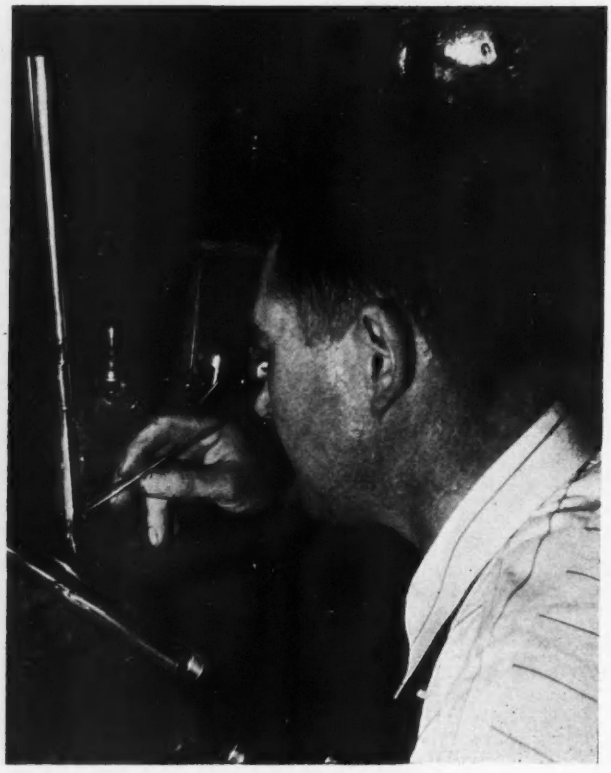
That is the formula by which, down through the years, has been compounded America's progress; not only the national progress, but the progress of specific industries, of corporations within these industries.

Growth and development such as have been enjoyed in the past quarter century by the Humble Company of necessity have come in considerable measure from the creative, imaginative minds of Humble people, whose efforts at self betterment and at making their work easier and more efficient have contributed toward the Company's prosperity. It has been a mutually beneficial program, for each year Humble has taken into its fold additional numbers of scientifically trained people, has given them time, facilities, resources, and encouragement for the development of better equipment, new techniques, more efficient methods. These scientists and technologists, and other employees not engaged in research work, in turn have originated or improved the equipment, techniques, and products that have made possible the Company's rise to a position of prominence in the industry.

Humble researchers have made significant advances in exploration for oil. For example, the world's first field-worthy gravity meter, an instrument for locating salt domes and other geologic structures, was made in Company shops. Likewise, the Humble Company developed the first underwater gravity meter, an instrument which can be lowered to the bottom of the sea in the exploration of submerged areas. Contributions have been made to electric and gamma-ray well logging, to seismic prospecting, and to the development of electrical surface exploration methods. Humble was first in the field of commercial alkylation in the United States; Humble research scientists have developed subsurface pressure gauges and thermometers for making measurements in wells and bottom-hole samplers for obtaining samples of liquids in boreholes. The industry uses gas lift valves and oil treaters which were conceived by Humble employees.

Contributions like these to the Company's and the industry's storehouse of technical advancement require continu-

CONTINUOUS RESEARCH in laboratory and shop bring to light advanced techniques and new equipment that help spell progress.



DELICATE ELECTRICAL INSTRUMENTS SO ESSENTIAL TO OIL PROSPECTING COME FROM WORK BENCHES LIKE THIS.

ing research on a large scale of the highest order. Research on such a large scale is costly; so costly, in fact, that it could not be carried on if the fruits thereof could not be protected. For this purpose and also for the purpose of assisting and guiding employee-inventors, there was established many years ago within the Company a patent group which files and prosecutes patent applications on ideas developed by employees.

While it is true that the group occasionally initiates proceedings on promising ideas from non-employee inventors in the field of the Company's business, it is the primary function of the patent group to handle proceedings on ideas originating in Company circles. For this purpose employees fall into two groups, contract and non-contract.

Contract employees, so called because they sign employment agreements assigning to the Company all inventions which they may make, are members of groups in research, development and operations who are charged with the responsibility of devising new and better equipment and methods, and are paid salaries based on their usefulness for that purpose. Non-contract employees are those who work in classifications in refinery, pipe line, production, or sales operations of a routine character in which little opportunity is afforded for making inventions. However, some do and while the patent group aids them in the procurement of patents, these employees retain title to their patents and the Company has only a *shopright* in them.

Naturally, the greatest number of new and potentially patentable ideas originates with the scientifically trained personnel in research work. In their pool of findings some ideas are more valuable than others, so that patent contact men in various departments and the central patent group must select those which look most attractive for follow-up.

This particular function and others of the patent group, as well as the provisions covering employees with regard to ideas and inventions, may seem somewhat involved, but that group's operations are designed entirely for the good of employees and the Company. Contract and non-contract employees are given assistance, and so far as the Company is concerned its principal aim in the acquisition of patents is defensive. The Company desires to protect its own operations; it seeks to be as free as possible of patent controversies; and it is eager to carry on the full program of research so essential to continued progress.

The vast majority of inventions coming from Company laboratories and shops and from the employees' home work benches result in improved operations, in the saving of time and money, in increased safety to employees, in the acquisition of new and better ways of doing things—all benefits which rarely permit of exact determination in terms of money, but which play a vital part in the Company's success.

Suffice it to say that the patent group serves indispensably in that it directly protects the vast amount of research constantly being carried on and that through this security it fosters thought, study, and progressiveness. And there is no doubt that Humble research has been, and is, abreast of the times and that frequently it has pointed the way to new and more fruitful fields of applied science.

By the way . .

A windfall of $3,330 was distributed recently to 125 employees in the form of Coin-Your-Ideas awards for the third quarter of the year. While all branches of the Company's operations were represented, unquestioned leadership went to employees in the Refining department. The central committee announced that eight Refining employees received $1,055 in the form of supplemental awards and that 89 shared $2,010 of the total initial award money. No other supplemental awards were granted in any other division of the Company, and initial awards were divided as follows: 14 to Production employees; two to Sales employees; and 12 to Humble Pipe Line Company employees.

PRESIDENT H. C. WIESS early in November was elected a charter trustee of Princeton University. He will be a permanent member of the board of the University from which he was graduated in 1909. Mr. Wiess also is a member of the the Board of Trustees of Rice Institute and a member of the corporation of the Massachusetts Institute of Technology.

Retirements

ALBERT C. KUNKLE, London Production, on October 1 . . . WADE H. CALLAM, SR., Baytown refinery, on October 14 . . . ARTHUR F. TEAL, Webster Station of the Pipe Line Company, on October 21 . . . WILLIAM W. RUFF, Talco Production, on October 27 . . . MRS. EMMA LEE LANGHAM, Crude Oil division, Houston Office, on October 30 . . . MRS. GENEVA M. DOZIER, Refining, Houston Office, on November 9 . . . JAMES M. NORRIS, Baytown refinery, on November 19 . . . MILLARD KINDER, Satsuma Station, Pipe Line Company, on November 21 . . . and MRS. LUTIE D. RESCH, Claim & Right-of-Way, Houston Office, on November 22.

Transfers and Promotions

Recent personnel changes in the Production department involved four district civil engineers: RUPERT F. CARROLL was promoted to district civil engineer, Willamar district, Raymondville; JAMES E. OZBURN, promoted to a similar post in the London district, Overton; VERNE E. WESLEY to a similar post in the Scott & Hopper district, Encino; and JAMIE M. SPILLER, civil engineer recently returned from military service, was transferred from the North Crowley district in Louisiana to the East Texas division office at Tyler as district civil engineer.

Changes in the Sales department saw LEON TRENCKMANN, assistant local manager for the city of Houston, promoted to Houston district retails sales manager, and W. S. DIXON, acting local manager at Galveston, transferred to Houston to fill the post vacated by Mr. Trenckmann.

Deaths

BURNETT C. KNIGGE, 34, rotary helper in Maurbro Production, died on October 11 . . . CLEM MORGAN, 48, porter at Anahuac Production, on October 15 . . . LEON C. INGRAM, 62, supervisor of the A & B Office, Houston, on October 21 . . . EDITH LOIS DURNELL, 32, stock record clerk at Baytown refinery, on October 25 . . . ARTHUR L. MORGAN, 55, senior clerk in Humble Pipe Line Company oil accounting, Houston, on October 31 . . . CALVIN S. LESLIE, 49, carpenter department, Baytown refinery, on September 5 . . . GARLAND W. MASSEY, 37, engineer at Pipe Line Company's Marshall station, on November 6 . . . LOUIS H. ENDERLE, 54, truck salesman, San Antonio Sales, on November 13 . . . CHARLES B. HUDSON, 53, Claim & Right-of-Way department, Houston, on November 13 . . . HENRY L. ITSCHNER, 47, tinner at Baytown refinery, on November 15 . . . LEE A. SMITH, 41, of the Compound plant at Baytown refinery, on November 4 . . . WILLIAM J. SPRIGG, 54, engineer at Humble Pipe Line Company's Hawkins station, on November 20 . . . and CLAUDE C. NEWTON, district construction foreman for Humble Pipe Line Company at Midland, on November 17.

Annuitants who have died in recent weeks are: ISIDORE S. MUNZESHEIMER, 71, a buyer in the Purchasing department until his retirement in 1939, on November 2; and THOMAS A. SMITH, 79, in Production department at Sour Lake until his retirement early in 1936, on November 13.

The HUMBLE WAY

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CLEAN CLOTHING for crew members is made possible by a washing machine provided by Humble on all rigs not using steam power. Where steam power is used, "blow barrels" are used.